THE
BOOK OF HEALTH

MALCOLM MORRIS.

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BY

SIR RISDON BENNETT, M.D., F.R.S.
JOHN S. BRISTOWE, M.D., F.R.S.
J. CRICHTON BROWNE, LL.D., M.D., F.R.S.
T. LAUDER BRUNTON, M.D., F.R.S.
JAMES CANTLIE, F.R.C.S.
W. B. CHEADLE, M.D.
CLEMENT DUKES, M.D.
JOSEPH EWART, M.D.
SIR JOSEPH FAYRER, K.C.S.I., F.R.S.
G. P. FIELD, M.R.C.S.
MALCOLM MORRIS, F.R.C.S., Ed.
SHIRLEY MURPHY, M.R.C.S.
J. E. POLLOCK, M.D.
HENRY POWER, F.R.C.S.
J. RUSSELL REYNOLDS, M.D., F.R.S.
W. S. SAVORY, F.R.S.
CHARLES S. TOMES, F.R.S.
FREDERICK TREVES, F.R.C.S.
HERMANN WEBER, M.D.

EDITED BY

MALCOLM MORRIS.

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PREFACE.

The object of this Work is to place before the general reader, in an intelligible form, and in language free from technical obscurity, the principal rules that should be adopted for the preservation of Health. Directions for the treatment of disease are purposely omitted, for it is intended to teach, not how disease can be cured, but how it can be prevented. The laws of public and private hygiene are now matters of vital interest to all classes of society, and it is generally recognised that carelessness and ignorance often lead to the establishment or the spread of disease which might in the first instance have been easily avoided. No work of authority, however, existed to which those desirous of readily obtaining information on special subjects could refer; hence the present publication, in the production of which the Editor has been honoured with the co-operation of eminent members of the Medical Profession. To these gentlemen he begs to offer his sincere thanks.

THE EDITOR.

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No inquiry is so common everywhere as that which has reference to one's health, and such salutation is natural, for good health is not only the prime condition for the use and enjoyment of present life, but it is also full of promise for the future. But although Life and Health are among our most familiar words, and in their ordinary meaning none are more widely understood, yet in their scientific sense no terms are more difficult to comprehend.

Life constitutes the grand distinction between the organised kingdom, including all plants and animals on the one hand, and the inorganic or mineral kingdom on the other. Apart from life the several lines of demarcation in structure and composition which have been from time to time laid down have been effaced as science in its progress has either swept away errors or revealed truths. It is true that the marks of difference are obvious enough in many cases, and in the majority, when collectively applied, are sufficient to solve any temporary difficulty that may occur; but most of them disappear, and the others are by no means conclusive, when applied to the simplest forms. Now the features under which Life appears are infinitely varied—various in form and in expression, varying extremely too, from absolute simplicity to the most elaborate complexity.

Let us glance at the phenomena of Life in ourselves. How many and diverse are the actions or functions which minister to it! There is digestion—a process for reducing food to a state of solution; absorption—a process for conveying it when so dissolved into the blood; the circulation—by which, as blood, it is conveyed all over the body to nourish it; respiration—for introducing oxygen to combine with the elements of the food and tissues, and at the same time to carry off one of the chief and most poisonous of the products of that combustion, carbonic acid; there are also the processes of secretion and excretion. There are extensive and intricate systems of organs for motion, the muscles; another, in its higher relations, more mysterious than all, the nervous system, for sensation; for consciousness, thought, and volition, the instrument of mind.

Now if we extend our view we shall see the same functions at play in the animals around us. Life in them presents the same features. Their vital actions are like ours. Digestion, absorption, circulation, respiration, motion, and sensation are accomplished in them as in us. And this resemblance is not confined to the higher animals only, but it may be extended far and wide into the animal kingdom. Nay, it does not altogether stop here. Plants are living beings and their life presents phenomena comparable with those of our own. However vague and far-fetched a comparison between the vital actions of plants and animals may at first sight or to superficial observation seem, the more thoroughly the subject is investigated the closer does the resemblance appear. The differences which are so obvious are of degree rather than of kind, and mask the similarity of their essential features. Plants require and take in food and air as we do, and circulate them through the system.

Heretofore the functions of motion and sensation were emphatically termed animal ones, on the assumption that they were absent in plants; and were thus distinguished from the others, digestion, circulation, respiration, and the rest which, as plants have long been known to possess them in common with animals, were therefore termed vegetative. But while it has been long understood that many of the simplest forms of animal life yield very little evidence of motion and still less of sensation, recent researches have gone far to show that certain movements in plants are due to contractile tissue as in animals, and to render it doubtful whether one is justified in denying altogether what may be properly termed sensation to all plants.

To establish this relation and community of function between man and the creatures around him, and between the animal and vegetable kingdoms, is a great step onward. The life of man, although a most intricate, is not an isolated problem, and its solution may be approached through the study of questions set in simple terms. But before proceeding further, let us review the several functions which together make up the life of the human body.

The Organic Functions, or the Functions of Vegetative Life.—The object of Digestion is to reduce the various substances used as food to a state of solution or minute division, so that they may be absorbed and carried into the blood. This is effected partly by mechanical and partly by chemical action. The digestive apparatus is of very elaborate construction. It consists of a long tube which extends throughout the body, and which is dilated at intervals into more or less capacious reservoirs. It commences at the mouth, to which succeeds a funnel-shaped cavity called the pharynx, leading into the gullet. This is a straight tube, which conducts directly downwards to the stomach, the most capacious portion of the whole alimentary canal, and capable, when distended, of containing about five pints. At the further extremity of this the small intestines commence. These consist of a convoluted tube some twenty feet in length, which occupies the greater part of the cavity of the abdomen, and at length terminates suddenly in a tube of larger calibre, the large intestine, some six feet in length, the last portion of the alimentary canal.

The whole of this long tube is lined with a soft, delicate membrane, very richly supplied with fine blood-vessels; and on the outside of this the wall of the tube is chiefly composed of muscle, by the contraction of which its contents are propelled onward. Into this tube numerous glands open and discharge their contents. In the very substance of different portions of the tube-wall itself minute glands are crowded in countless numbers, and at intervals, through longer and larger ducts, the secretions of the principal glands find their way into the canal, to mingle with its contents. Thus into the cavity of the mouth the salivary glands pour the saliva ; into the intestines, a few inches below the stomach, the liver pours the bile, and the pancreas its secretion.

When food is introduced into the mouth, it is masticated, ground by the teeth, and mixed with abundance of saliva. The presence of food in the mouth, through certain nerves, excites the salivary glands to the formation of saliva, and this then flows freely into the mouth. The food is thus broken up, softened, and reduced to pulp. In this condition, by the action of the tongue and cheeks, it is formed into a bolus, and lodged on the surface of the tongue ; by the pressure of this organ upward against the palate the food is carried backward through the fauces or passage into the pharynx, where it falls within the grasp of the muscular wall of the tube, and is conveyed into the stomach.

It may be well to pause here for a moment to notice an exquisite arrangement for the protection of the air-passages from the ingress of food. The windpipe opens above, through the larynx, into the front part of the pharynx, just behind the tongue. All food, as it is swallowed, has to pass by this aperture, and a choking fit would be the constant result if any of it passed the "wrong way." To prevent this, immediately in front of the aperture of the glottis, a firm elastic tongue-shaped structure, called the epiglottis, stands more or less upright. Food, as it is carried backward, impinges against this, and either glides off on one side or passes over it and bends it backward, as a lid, over the aperture. Furthermore, the aperture itself is guarded by most sensitive muscles, which, on the hint of the slightest irritation, can close it completely by approximating its sides ; and lastly, in the movement of swallowing, the whole structure is drawn forward and upward, and the aperture itself becomes more vertical, so that all risk of intrusion is considerably diminished.

While in the mouth, food is not only reduced in consistence, but certain substances in it undergo important changes from the action of the saliva. Soluble substances, such as common salt, are at once dissolved, and this rapid and direct solution is an important condition of taste and flavour. Starch, which is so abundant in certain kinds of food, as bread and potatoes, is acted on chemically, and converted into grape-sugar. Not the whole of the starch taken is thus changed by the saliva in the mouth, for the quantity supplied is probably too limited, and the time allowed is certainly too short, for the complete conversion of all that is taken; but the change begun in the mouth is continued to some extent in the stomach, until the action of the alkaline saliva is overpowered by the acid juice of the stomach itself, and it is subsequently resumed by the action of other agents in the small intestine. Food is swallowed by a muscular act. It does not fall passively into the stomach ; but is forced along by the contraction of the tube from above downward. Even liquids, as water, are thus conveyed. Thus a person may swallow food and drink in any position, even when upside down.

When food has passed into the stomach it is subjected to most important changes.

When excited by the presence of food there, innumerable small glands, set in the walls of the stomach, pour out, in great abundance, a clear watery fluid, strongly acid, called gastric juice, which not only dissolves, as water would do, all soluble substances which have escaped the action of the saliva, but which has also a remarkable solvent action of a chemical kind on some of the chief constituents of the food, on those out of which subsequently flesh is formed, which are called albuminous principles. These are at once attacked by the gastric juice; are softened, disintegrated, and dissolved. But they are not merely dissolved. They are at the same time somewhat changed in their constitution, and so rendered more fit for absorption. This change and solution of the albumens by the gastric juice, like the change of starch into grape-sugar by the saliva, seems to be a purely chemical one, for it may be effected out of the body when these substances are mixed with the fluid. Nay, even a fluid resembling in this respect the natural gastric juice may be artificially prepared by soaking portions of the membrane of the stomach in water, and adding to the solution a few drops of hydrochloric acid. It appears that the quantity of gastric juice secreted by the stomach is enormous. It amounts probably, on an average, to many pints: from ten to twenty daily. Considering the total quantity of blood in the body to be about fourteen pints, it would be impossible to understand how this quantity of fluid could be drawn off from it, except for the fact that it is being continually absorbed back into the blood, soon after its escape, charged with the substances it has dissolved; so that, although so large a quantity is in the course of hours formed, at no given time does the stomach contain more than a few ounces of gastric juice.

During the whole period that the food is in the stomach the action of the gastric juice upon its contents is assisted by constant movement, due to contraction of the muscular walls. The food is thus churned, as it were, whereby every part of it is more thoroughly exposed to the action of the juice. The solution of successive portions is still further facilitated by the removal, through absorption, of that already dissolved; so that at length what remains consists chiefly of oleaginous substances, such as fat, of some starch not yet fully converted into sugar, and of other substances which are indigestible. All this is reduced to a tolerably uniform consistence, something like gruel, which, under the name of chyme, is passed onward into the commencement of the small intestine.

Here the chyme, which has an acid reaction when it leaves the stomach, soon undergoes important changes. The bile and pancreatic juice are mingled with it, and its reaction then becomes faintly alkaline. The oleaginous matter of the food —the fat, already in a state of disintegration—is now still further broken up into extremely minute particles. In fact, it is reduced very much to the condition of an emulsion, and in this form it is capable of being absorbed by certain structures in the wall of the intestine, presently to be spoken of. The fat, in the condition just described, appears among the other constituents of the chyme as a white opaque fluid, very like cream, and called chyle. What remains of starch in the food is converted into sugar, chiefly by the action of the pancreatic juice, which resembles that of the saliva. The small intestine propels its contents onward. All substances in a state of solution, and the chyle, are gradually removed by absorption, and some part of what remains is still further acted on by a juice which is poured out from minute glands in the wall of the intestine, and made soluble. At length the residue is carried into the large intestine, and this, consisting mainly of indigestible matter, substances which have resisted the action of the various solvents to which they have been exposed, of the remains of the several secretions which have acted on the food, and of some matters which have been thrown into the canal as excrementitious by the agency of some of its glands, is cast out.

The process of Absorption—the means whereby digested food is passed into the blood—follows that of digestion. This is very largely accomplished by the minute blood-vessels themselves. Their walls are composed of a very thin delicate membrane, which readily allows of the passage of fluid through them, and such a passage is greatly promoted by the current within. These vessels, which, as already mentioned, are most richly supplied throughout to the mucous membrane that lines the alimentary canal, absorb at once the several substances that are in a state of complete solution, and the fluids which have acted on them. Thus the gastric juice, charged with the albuminous substances it has dissolved, is absorbed, so also is the soluble grape sugar into which the saliva has converted the starch; but the fats, the oleaginous substances of the food, are not thus absorbed by the blood-vessels. Although, as already explained, they are reduced to a state of very minute division, even to an emulsion, yet they are not actually in solution, and so they find their way into the blood through other channels.

The surface of the mucous membrane of the small intestine may be seen, with the microscope, to be studded all over with minute conical eminences, called villi. These, which exist in enormous number—as many as from forty to ninety being counted in a square line—are constructed after the fashion of the mucous membrane from which they spring; but in the interior of each villus is the commencement of a single vessel, or minute cluster of vessels, which does not contain blood, but whose office is to absorb the chyle. Hence, from the appearance of this milk-like fluid these vessels are called lacteals. These lacteals, which begin in the villi, pass in great number from the wall of the intestine to a common trunk, which commences in front of the spine, in the loins, and runs upward to the left side of the neck, behind the collar-bone, where it discharges its contents into one of the great veins, where, of course, the chyle mingles with the blood.

So of the products of digestion, one part, that which is forthwith reduced to a state of perfect solution, finds its way at once through the walls of the blood-vessels into the blood, and this is conveyed by the arrangement of the vessels that absorb it at once to the liver, where it is subjected to changes, which result in bringing it into closer relation with the blood; the other part, which is converted into chyle, finds its way to the blood, not at once, but only indirectly, through an extensive system of vessels, the lacteals. Now, during the passage of the chyle through the lacteals it undergoes important changes, and these changes, which result in transforming the chyle into a fluid much more closely resembling the blood, are chiefly effected by the agency of certain bodies through which the lacteals pass in their course. These bodies, or glands, which in size and shape may be likened to small almonds, are very numerously set in the path of the lacteals.

But this remarkable system of vessels, which in man and the higher animals stands, as it were, between the materials that it absorbs and the blood into which these materials are at length cast, is not confined to the alimentary canal. Vessels of a like kind are distributed all over the body, and are found abundantly in some of the tissues, but they are for the most part so fine and delicate that they are apt to escape observation in an ordinary dissection. Those which are distributed over the body generally, of course, cannot contain chyle, for this is only formed in the small intestine as the immediate product of digestion, but these contain a transparent, colourless fluid, called lymph, and hence these vessels, in distinction to the lacteals, are called lymphatics. The immediate source of this lymph and the conditions under which it is formed are not yet clearly and fully understood. In fact, the exact mode in which the lymphatic vessels commence in the tissues, and their relation there to the blood-vessels proper, has not yet been quite satisfactorily made out; so the questions, how far lymph is from blood, and to what extent it may be regarded as an excrementitious product, are still open ones. But that this lymph is very far from consisting entirely, or even principally, of refuse matters; on the contrary, that it must play some future part of importance in the economy, would appear from the fact that it finds its way into the blood after passing through lymphatic glands, and that before it arrives there much of it is allowed to mingle with the chyle in a common vessel.

Thus, by digestion and through absorption, the materials of our food find their way into the blood. They do not reach the blood as blood, but after they have entered the current of the circulation they have to be still further elaborated. The final steps of the change, at all events, must be accomplished in the blood itself. Thus the fluid of the blood is crowded with myriads of microscopic bodies, called blood-cells. These are of two kinds, known respectively as the white and red blood-cells. The proportion of these varies, but the red are always in excess of the white. Cells resembling the white blood-cells, and which are gradually converted into them—in short, young blood-cells—are found in chyle and lymph in greater abundance and more fully formed as these fluids, in their course towards it, approach the blood; but the red blood-cells are not found in them; they exist only in the blood itself, and to them its characteristic colour is due. The blood, although the common source of supply to every part, and although constantly replenished by the crude material which it has to make into the likeness of its own substance, nevertheless maintains its condition. The great mass of it is uniform in structure and composition. It possesses, then, the characteristic attributes of vitality—it is a living fluid. The blood itself has life.

The fluid portion of the blood, called liquor sanguinis, or plasma, consists of various substances held by water in solution, organic compounds of different groups, albumens and hydro-carbons, and various inorganic salts. The red cells play a conspicuous part in the purification of the blood by the function of respiration, and this by virtue of their especial affinity for oxygen. The white cells, out of which the red are formed, have of late years attracted particular interest, from the discovery that they are capable of spontaneous movement. While alive, they may be seen, under the microscope, to change their form, to throw out processes and to retract them; in short, to behave as simple fragments of living protoplasm will do in other circumstances, as in vegetable tissue and the lower forms of animal life. These cells, too, can escape through the walls of the finest blood-vessels without rupture, and wander far and wide into the tissues.

But in order that the blood may be enabled to fulfil its high offices it must be brought into relation with the several structures of the body: it must circulate; and the Circulation of the blood is provided for by an elaborate apparatus, the exquisite mechanism of which never fails to excite the wonder of all who study it.

The various structures of the body are traversed by a net-work of very fine and delicate vessels, called capillaries, the walls of which are transparent and permeable, so as to allow of transmission and active interchange between the blood which flows through them and the tissues in the midst of which they are placed. It is through these capillaries that the several structures are nourished, that they receive from the blood the materials of supply, and return to it the products of their waste. The closeness of this net-work of vessels, or, in other words, the supply of blood, varies very widely. Some structures, as the skin and the muscles, are highly vascular, and contrast strongly with the bones and ligaments. The blood is brought to these capillaries from the heart which propels it, by the arteries, which form a system of pipes laid down in every direction for the purpose, and it is returned from the capillaries to the heart by the veins, another system of pipes, which, for the most part, run in company with the arteries. Thus the blood circulates. It starts with a rush from the heart by the force of its action; passes along the arteries everywhere to the capillaries; through the capillaries it performs its great office of nourishing the body, and then by the veins finds its way back again to the heart. The blood, then, in its circulation through the capillaries, must undergo great changes, for it gives up part of its substance and of its oxygen, and receives in exchange refuse matters, and becomes charged with carbonic acid gas. Thus arterial blood differs from venous blood in composition and in colour. Arterial blood is of a bright scarlet hue, and venous blood of a dark purple; and the contrast in colour is in general so striking, that when a person is bleeding one can usually tell, if either an artery or a vein be wounded, from which vessel the blood flows.

After the blood, then, has circulated through the tissues, it is in a measure spoiled for further use, so when it returns to the heart as impure blood, it must be restored before it can be again sent forth. This is largely accomplished by its passage through the lungs; so when the blood arrives at the heart after nourishing the system, it is transmitted to the lungs to be purified by the act of respiration, and then returns to the heart fit again for its work. No portion of the blood, therefore, finds its way twice through the system without meanwhile having passed through the lungs. In the lungs, as will be presently explained, it receives fresh oxygen and gives off carbonic acid, and it is changed there from venous to arterial. Thus there are two chief circulations in the body: one called systemic, during which the blood is changed from arterial to venous, sometimes styled the greater circulation; and one called pulmonic—the lesser circulation—by which venous blood is changed into arterial; and every portion of the blood is subjected alternately to these two processes.

The great agent in the circulation of the blood is the heart, which, in relation to its office, is a double organ. One half of it, the left, drives the blood through the system; the other half of it, the right, drives the blood through the lungs. Let us look at its action somewhat more closely. The heart is substantially a powerful muscle. The blood is received into cavities in the interior, and is propelled therefrom by the energetic contraction of their walls, which squeeze it out into the arteries. The two sides are constructed upon the same plan, have about an equal capacity, and work in the same way; only that the wall on the left side is much thicker and stronger than on the right, because it has more work to do. The two cavities with these muscular walls are called ventricles, and receive the blood, the one from the system, the other from the lungs. But the ventricles do not receive the blood directly from the veins. It flows to the heart from the veins into two ante-chambers, called auricles, which pass it on to their respective ventricles. The auricles, which have a capacity almost or quite equal to that of the ventricles, have also muscular walls; but these are far thinner than those of the ventricles, so that, when empty, the auricles appear as insignificant structures set upon the ventricles, which remain firm and preserve their shape, so familiar to us as a standard of comparison. The function of the auricle is in direct relation to that of the ventricle. If there were no auricle or ante-chamber intervening, the blood would have to find its way into the ventricle from the large veins more gradually; but as it is, it accumulates in the auricle from the veins, as in a reservoir, and then is at once and abruptly transmitted to the ventricle, which it fills, and which then contracts and sends it outward.

So, then, the human heart has four cavities—two ventricles and two auricles; on each side a ventricle and an auricle. Each auricle communicates directly with its ventricle, but between the two sides there is no direct communication. They are bound together in one organ, they work together, act synchronously; but in their offices they are distinct.

The course of the blood through the heart and the plan of its circulation may now be understood. Starting from the left ventricle, it is driven over the body, through the arteries, into capillaries, and onward to the veins. By them it is returned to the right auricle, which transmits it to the right ventricle. The right ventricle drives it through the arteries to the capillaries of the lungs, and onward into the veins, which return it to the left auricle, and this transmits it to the left ventricle, whence it starts again to the system.

And it is well to pause here for a moment to observe the means by which its onward course is secured, and regurgitation of, or confusion in, the current prevented. The construction is so simple, and its purpose so obvious, that it may be easily understood, and the interest of it is enhanced by the fact that precisely the same kind of mechanism is employed in various ways in the construction of different kinds of instruments. Every one understands the principle of action of a flood-gate; every one knows how these are employed in the construction of the locks on our rivers; every one can explain, too, the purpose for which valves are introduced into pumps and syringes, and their mode of action. When water is driven in the required direction, they are opened, and offer no hindrance to its flow; but when it would regurgitate, the backward pressure closes them, and not a drop can pass. In the heart there are such valves, only singular in the exquisite delicacy of their finish and the perfection of their action. Each ventricle has two orifices: one through which the blood flows in from the auricle, another through which it flows out into the artery. Each of these orifices is guarded by valves, which differ in shape and other details of construction, but which work in the same way. When the ventricle contracts and expels its blood, the orifice which leads back into the auricle is closed by the valve there, and so blood can find its way only onward into the artery. When the ventricle ceases to act, the distended artery, recoiling on the blood, closes its valve, and so no blood can return to the ventricle.

Each action of the heart, in a healthy adult, occupies something less than a second of time. About half of this is taken up by the contraction of the powerful ventricles by which the blood is driven into the arteries; during the other half the ventricles are dilating and re-filling. The contraction of the auricles, which immediately precedes that of the ventricles, is more sudden, and occupies only one-eighth of the whole period. During the remaining seven-eighths they are gradually being re-filled. The contraction of the ventricles causes the beat of the heart, for by their action the heart is not only altered in size and shape, but, owing to the spiral arrangement of the muscle, it is vigorously moved. The front of it is tilted upward with a slight curve to immediately behind a particular portion of the wall of the chest on the left side, just below the fifth rib, where this stroke or impulse, as it is called, can usually be felt. Moreover, by the beating of the heart certain sounds are produced, which can be heard when an ear is placed over its region. Two sounds, differing in length and character, can be detected, followed by an interval of silence. The first sound is the longest and dullest, and is synchronous with the impulse or stroke of the ventricles, and is probably due to the closure of the valves between the auricles and ventricles. The second sound, which immediately succeeds, is shorter and more abrupt, and is certainly due to the closure of the valves between the ventricles and great arteries.

The arteries, which ramify all over the body to conduct blood to the tissues, in their arrangement may be compared to the stem and branches of a tree. The great trunk, which starts from the left ventricle, gives off branches in its course. These divide and sub-divide as they pass outward, becoming more numerous and much smaller, until they gradually end in the capillaries. When an artery divides, the united area of the branches generally exceeds the area of the trunk, so that the total capacity of the arterial system greatly increases as it becomes more distant from the heart. Where the arteries join the capillaries their total capacity is something like eight hundred times greater than the capacity of the first vessel at its origin from the heart.

The arteries are not rigid and merely passive tubes, but besides being very strong, possess two properties which are quite distinct, one physical, and the other vital. They are eminently elastic, capable of expansion and extension, and of recoil when the force which stretches them is withdrawn. This may be easily shown after death, when an artery is removed from the body, for the property is a physical one. The elasticity of the artery plays an important part in the movement of the blood. If the arteries were rigid and unyielding tubes, a considerable portion of the heart's force would be uselessly expended against their walls; but as it is, they yield and are distended by the blood which is driven into them, and then in turn recoiling on their contents, force the blood onward in the direction that it should go, for the valve at the commencement prevents its return. Thus successive waves of distension are carried along the arteries from within outward, each one being due to a beat of the heart, and these waves can be detected by the finger whenever it is placed on an artery large enough and superficial enough to be felt, as at the wrist, where they are recognised as the pulse.

This intermittent movement of the blood through the arteries is strikingly shown in the manner in which they bleed when wounded. When an artery is cut across, the blood spurts out with great force to a distance of several feet; but the flow is not continuous. It escapes in a series of jets, the long, slender scarlet stream rising and falling with each beat of the heart, and this pulsation of the blood stream tells at once that it comes from a wounded artery.

But as the blood traverses these elastic tubes the abruptness of the heart's stroke becomes gradually broken and the current equalised; so that the greater the distance from the heart the less obvious is the pulsation, until at length in the capillaries the rate of the stream becomes uniform.

But the arteries are not only elastic; they possess the vital property of contractility, and this is due to very delicate fibres of muscle in their wall. The arteries are not uniformly endowed in this respect; as a rule, this muscular power increases as the arteries become smaller. Those towards the capillaries are the most contractile. This property serves them in more than one way. By affecting their calibre, it enables the arteries in great measure to become adjusted to the amount of blood they contain. By virtue of the elasticity already noticed, they can expand, and consequently contract; but the expansion, which is due to their elasticity, must depend on the pressure of the blood within them. It is a passive state. But their vital contractility is an active one, and by it they are enabled, within limits, to regulate the size of the stream; that is, the quantity of blood which passes through them. Thus the amount of blood that they distribute to any particular organ is by no means invariable. It is determined by the wants of the part itself. When an organ is in active operation, it requires and obtains more; when comparatively quiescent, it needs and receives less. This adjustment of supply and demand is effected through a portion of the nervous system, which establishes a communication between the part to be supplied and the arteries which supply it, and these can respond to the signal they receive by virtue of their muscular tissues.

The veins form a system of vessels which in general arrangement may be roughly compared to that of the arteries. They commence from the capillaries, and gradually uniting, form fewer and larger trunks as they proceed onward to the heart. The total area of the venous system—that is, its capacity—is at least twice as great as that of the arterial; and moreover, the veins, although their walls are composed of structures similar to those in the arteries, possess them in different proportion and yield more readily to the pressure of the blood. Hence, when from any cause the flow of blood through them is obstructed the veins swell largely, and the superficial ones stand out prominently under the skin. Most of the veins, especially those that lie amongst the muscles, contain at intervals valves in their interior, which prevent the regurgitation of the blood; for by the time the blood reaches the veins the greater portion of the heart's force has been expended, and it returns in an equable and comparatively languid stream.

Now, the relation of the several parts to each other of this elaborate vascular apparatus must be clearly understood. The work of the blood is carried out in the capillaries; the heart, arteries, and veins constitute simply an apparatus for the appropriate distribution of the blood. Although the capillaries are such minute vessels, and although the length of capillary structure that any given portion of the blood has to traverse may be measured for the most part by the fraction of an inch, yet they form such a vast net-work throughout the system that by far the greater part of the whole quantity of the blood in the body is contained in them. The amount altogether in the heart is only a few ounces, probably not more than four or five. The quantity in the large arteries and veins together would be but a small fraction of the whole. The great mass is always contained in the smallest vessels in the substance of the tissues; and the rate of the blood current through the successive portions of the vascular circle must be inversely as their area. Thus the blood moves fastest in the arteries, perhaps at a rate of more than a foot in a second soon after it leaves the heart. Then as the capacity increases the rate diminishes, until in the capillaries the slender streams are hardly at the rate of two inches in a minute, and in the veins, again, not half so rapid as in the arteries.

Moreover, while in the capillaries the stream is most subject to variation. As already observed, the amount that passes through the same organ varies widely at different times, under different conditions; but even in different portions of the same structure local variations may be constantly observed. As every one knows, the circulation of the blood may be seen in transparent parts, as, for instance, in the web of the frog's foot or of the bat's wing. As we watch it, the arterial stream of supply and the venous stream of return may be tolerably constant for hours, but between them, throughout the field of observation, the capillary circulation is subjected to frequent fluctuation. Now, one portion of the net-work is more distended than another; sometimes a vessel here and there seems too small to admit the blood-cells even in a single file, and only fluid passes; but, again, a cell or two make their way into it, and then others follow. And there can be little doubt that although the blood finds its way into the capillaries, and through them by the force of the heart's action, yet while in the capillaries it is subjected to other influences which largely affect its flow; and these depend on the changes which therein take place. When these changes are normal and free the capillary circulation is promoted by attractions between the tissues and the blood; when they are obstructed, the capillary circulation is obstructed too. This great fact lies at the root of the mischief which is observed in inflammation and in other morbid processes.

The pulmonary, or lesser, circulation has been already alluded to: the effect of which is to send the blood that has been rendered impure during its passage through the tissues to the lungs, so that it may be purified by the act of Respiration.

The two lungs occupy the greater portion of the cavity of the chest. They are highly elastic, sponge-like structures, in the substance of which the blood and air are brought together. In its simplest form, as it appears in some of the lower animals, the lung is a sac, the wall of which is composed of a very delicate transparent membrane. On this wall is distributed a net-work of fine capillaries, and the cavity in the interior is filled with air. Through the delicate membrane, which is the only structure that intervenes between the blood and the air, oxygen freely passes from the air into the blood, while the carbonic acid gas from the blood freely passes into the cavity and mingles with the air. Thus respiration is carried on. The human lung, although a far more elaborate organ, is constructed upon the same plan. The windpipe commences above, in a special organ called the larynx, in which the voice is produced, and which, as already mentioned, opens into the front part of the pharynx, at the base of the tongue. The windpipe is continued downwards into the upper part of the chest, where it divides into two branches, one of which passes to each lung. These bronchial tubes divide and sub-divide throughout the substance of the lung after the fashion of the branches of a tree, and at length end in irregular cavities, around which, and opening in them, minute sacs, or air-cells, cluster in great numbers.

The windpipe and bronchial tubes have firm, stout walls, which are further strengthened by rings of cartilage, or gristle; and they also contain muscular fibres, by which their capacity may, within certain limits, be adjusted, and which doubtless enables them to assist powerfully in the expulsion of matter, such as phlegm, that may have to be from time to time dislodged. But the walls of the air-cells are composed of a very delicate membrane, and covered with a rich net-work of fine capillaries, through which, of course, blood sent from the right side of the heart is constantly flowing. It has been calculated that the human lung contains from five to six millions of these air-cells, the membrane of which, if spread out, would be equal to a plane surface of at least from ten to twenty square feet. The air which enters by the windpipe finds its way freely into the cells, and so comes into close relation with the blood. By the mechanism of respiration, fresh air is being continually drawn into the interior of the lungs, and that which has been used is expelled. Nowhere can the successive stages of progress of an organ, from its first condition, which is one of extreme simplicity, to its most elaborate state in the highest animals, be more clearly traced than in the lung: in its rudimentary form, a mere membrane between the blood and the air; then the extent of surface for exposure is increased by folds, either outward, in the form of gills, for aquatic respiration, or inward, as in lungs, for aerial respiration.

In man and the higher animals air is drawn into and expelled from the lungs by the movements of the chest. The cavity of the chest is everywhere closed to the admission of air, except through the windpipe, which leads into the lungs. If the cavity of the chest be enlarged, the additional space is forthwith occupied by air, which rushes into the lung, and its elastic structure expands. If the cavity be diminished, the elastic lung contracts, and the air is expelled. In each case the lungs adapt themselves to the movement of the chest-walls. In inspiration, the chest is enlarged in every direction by powerful muscles. The chief muscle of inspiration forms the floor of the chest, and separates it from the cavity below. It is called the diaphragm. When relaxed, it is dome-shaped, and rises up into the cavity of the chest. When it contracts, it descends, and becomes more nearly plane, and thus the space is deepened vertically. Between the ribs are muscles, which raise them, and thus enlarge the chest horizontally. When the force is relaxed, the chest-walls recoil by their elasticity; but this movement also is assisted by certain muscles attached to them. Thus each act of respiration consists of an inspiration, whereby the cavity of the chest is enlarged, so that air rushes in and the lungs expand, and of an expiration, whereby the chest-wall and lungs contract, and air is expelled. The respiratory movements are regular, like the pulse, but less frequent. They occur from fifteen to eighteen times in a minute.

The movements of respiration are very obvious. Every one is familiar with the rise and fall of the chest. But if this expansion of the chest-wall be carefully watched, a difference may be observed between men, women, and children. In men, the expansion is throughout more equable; the chest enlarges considerably in every direction. In women, the movement of the upper portion of the chest-wall is more free in proportion to the lower. No doubt this deficiency of movement of the lower ribs in women is due in large measure to the mode of dress; but even naturally it would appear that, in proportion to that of the lower ribs, the movement of the upper ribs is more free in women than in men. In children, the chief enlargement of the chest in inspiration is in the vertical direction, and due to the descent of the diaphragm; so, when the respiration of a child is observed, the rise and fall of the abdomen, which alternate with the movements of the chest, is very marked, for as the diaphragm descends it presses upon the abdominal contents, and the walls yield.

In respiration, air is alternately drawn into and expelled from the lungs; but the lungs are not completely emptied and re-filled by each act. Only a small fraction of the whole quantity of air in the lungs is each time changed. By an ordinary expiration, about 20 or 25 cubic inches of air are expelled, and an equal quantity is drawn in by inspiration. After expiration there still remain about 200 cubic inches of air in the lungs. Even the most forcible expiration can only further expel about half of this, so that then there still remain about 100 cubic inches within. The most forcible inspiration can introduce about 100 extra cubic inches of air; so that, in relation to the capacity of the chest and the amount of air in the lungs, the proportion changed by each act of ordinary respiration is very small: not more than one-eighth or one-tenth of the whole. The air which flows in and out in ordinary respiration is called tidal air; that which remains after an ordinary expiration is called reserve air; that which remains after the most forcible expiration is called residual air; and the excess which can be introduced by the most forcible inspiration is called complemental air. The maximum amount represents, of course, the capacity of the lungs. Even after death, when the lungs are removed from the body, they are very light and buoyant, owing to the quantity of air they contain; nor can the whole of this air be driven out, even by very powerful compression.

Now, as the tidal air bears so small a proportion to the residual air, it becomes an interesting question how the air which remains in the lungs can be changed. This is effected by a physical law—the law of diffusion of gases. When two different gases are brought together, they diffuse into one another until they are thoroughly mixed. The rate of diffusion of different gases depends on their density; the rate of diffusion of any gas is inversely as the square root of its density. So the fresh air from without diffuses into that which is within, and thus the change is constant.

The chief change which occurs between the blood and the air in the lungs is that oxygen gas passes from the air into the blood, and carbonic acid gas passes out from the blood into the air. Both venous and arterial blood contain both oxygen and carbonic acid, but in different proportion. In arterial blood there is in volume about 16 per cent. of oxygen and 30 per cent. of carbonic acid. In passing through the body, oxygen is gradually removed, and carbonic acid added, so that venous blood, when it flows to the lungs, contains about 6 per cent. of oxygen and 35 per cent. of carbonic acid. Thus, in the lungs, about 10 per cent. of oxygen is added to the blood, and 5 per cent. of carbonic acid is given off.

The attraction of blood for oxygen is due to the red blood-cells, the substance of which holds oxygen in loose combination; and it is mainly by the action of oxygen on the substance of these blood-cells that the colour of the blood is changed. Hence the red blood-cells have sometimes been styled oxygen-carriers.

But the introduction of oxygen and the escape of carbonic acid, although the chief, are not the sole changes that occur in respiration. Water from the blood is added to the air in the form of vapour, and is readily deposited when the warm breath is chilled by falling on a cold surface. The amount of water which is thus lost depends mainly on the amount which is already in the air. When air is expired it is saturated with watery vapour, and its capacity in this respect is determined by its temperature. Air inhaled at the ordinary temperature is warmed while in the lungs, and expired at a temperature of about 98° Fahr. Thus its capacity for watery vapour is increased. On an average, in twenty-four hours about ten ounces of water are thus carried off by respiration. Minute traces of organic, volatile, and some other substances, are also added to the air, and these are often revealed by the odour of the breath.

Atmospheric air is composed of a mixture of oxygen and nitrogen, in the proportion by volume of one to four. But even the purest air contains traces of other substances, and the air we breathe is often by no means of the purest. Not only are traces of carbonic acid and ammonia found in it, but in many places of low situation, especially in the neighbourhood of populous and manufacturing districts, various substances in a solid form are suspended in it. Smoke, for instance, often obviously abounds, and many persons are made painfully conscious of the effect of such impurities in a London fog. Such substances, although foreign to the natural constitution of the atmosphere, are yet, when suspended in it, carried into the bronchial tubes, and would doubtless become the source of perpetual irritation but for an exquisite structure by which they are arrested before they reach the delicate air-cells, and carried back to the larger bronchial tubes, whence they may be expectorated. The surface of the whole mucous membrane of the pulmonary passages, from the lining of the nostrils to the smallest tubes which end in the spaces leading to the air-cells, is covered throughout by a layer of very minute hair-like filaments, called cilia. These fine hairs, which can be seen only by a high power of the microscope, are in perpetual motion, by which waves constantly flowing in a direction towards the outlet are produced. When this motion is witnessed, one is reminded of the effect of a current of wind over a field of ripe corn. But here the movement is an inherent one, and due to the action of a contractile substance. If, while we watch this action, we introduce into the neighbourhood of the cilia some particles of a finely-divided substance—as, for instance, of carbon, such as from smoke—we see that the instant they alight on the waves they are wafted onward. Thus the whole surface of this vast tract is being continually swept, and the products are often seen in the discoloration of the sputa. The air so sifted, and comparatively pure, finds its way to the pulmonary cells, and the oxygen through their walls to the blood.

Inasmuch as the whole of the blood has to flow alternately through the system and the lungs, it follows that in any given period as much blood must flow through the lungs as through the system. But the total capacity of the lungs for blood is much less than that of the system: perhaps not more than one-fifth; so that the rate of the pulmonary circulation must of course be proportionately faster. And it may be observed, too, that while everywhere else throughout the system the arteries carry bright blood, hence called arterial, and the veins dark blood, hence called venous, the pulmonary arteries carry dark venous blood to the lungs, and the pulmonary veins return bright arterial blood.

Venous blood in the lungs excites, through a certain portion of the nervous system, the muscles of inspiration. These respond; and by their action enlarge the cavity of the chest, and thus air is introduced. In ordinary circumstances, during health, this process is continued without any consciousness of it, but it may nevertheless be brought within the range of both consciousness and the will. When attention is directed to the movements of respiration, we become aware of them, and we may, to a certain limit, control them by the will. Nay, by watching them, we disturb them. We only breathe quite naturally and regularly when the act excites no attention. By voluntary effort we may for a short time suspend the action altogether, but at length the want of breath, due to the accumulation of venous blood, becomes too strong for the will, and, in spite of the utmost resistance, we breathe again. The respiratory movements are peculiar in their relation to consciousness and to the will. Habitually beyond consciousness, we can nevertheless feel them, if we will. But it is only when the function is perfectly performed that it escapes attention. Like other functions, but this in an especial degree, any hindrance to the process or embarrassment of the movements soon produce strong sensations, which rapidly rise into pain and agony. For if, from any cause, the blood cannot undergo due changes in the lungs, the pulmonary circulation is hindered. Venous blood accumulates, and vehemently excites the pulmonary nerves. The distress arising from want of breath grows stronger; more powerful efforts are made by the muscles to introduce air. If relief be not obtained, the excitement and suffering are for awhile continued, until the increasing impurity and engorgement of blood in the nerve-centres deaden their sensibility. Then they fail in action, and death soon supervenes. Thus persons die when suffocated. At first there is a severe struggle for air; then convulsions and delirium, insensibility and death. And the prime cause of the mischief—the overcharge of the system with venous blood—is plainly revealed in the aspect of the sufferer, even for some time after death. The surface of the body, more particularly of certain parts of it, as the face, hands, and feet, becomes of a dusky livid colour, from the dark blood in the vessels of the skin; and parts, such as the lips, which yield most readily to distension, become greatly swollen from engorgement. In some forms of disease, which, as they advance, interfere with the great function of respiration, as various affections of the heart and lungs, the gradual progress of these effects of defective aeration of the blood may be distinctly traced. At first, it may be, the patient suffers only from shortness of breath. He can breathe in comfort when calm and quiet; but excitement, or exertion, or any disturbance, is too much for him, and he pants for want of breath. Then the extra demand cannot be adequately met by any effort, and when the circulation or respiration is at all disturbed the surface becomes dusky, and he is greatly distressed. At length, even when the needs of the system are reduced to the lowest degree by rest, and he is placed in the most favourable position, the blood is never fully aerated. The anguish increases until, as the blood grows more impure, the functions of the brain fail, and he passes through delirium and insensibility to death.

The action of the respiratory muscles is remarkable in that they may be aroused, not only as they are constantly, and always most strongly, by the lungs, but also by the skin. The relation between the surface of the body and the function of respiration through the nervous system is a very close one, and some striking instances of it must be familiar to all. A sudden plunge into very cold water is apt to produce temporary embarrassment, and although this might be perhaps partly explained by the contraction, consequent on cold, of the vessels of the skin, and a corresponding fulness of the deeper organs, yet that this cannot be the principal cause appears from the fact that a like result may be produced by certain impressions on a very limited portion of the surface. A cold douche upon the head, for instance, will often interrupt inspiration, and provoke for a moment or two disorderly action. A morsel of ice dropped down the back between the skin and clothes will disturb also the equanimity of the respiratory movements, and when flagging in faintness, they may often be aroused by dashing cold water on the face or chest, or by slapping the surface with a cold wet towel. No explanation of the acknowledged success of these domestic expedients is satisfactory which excludes the intervention of the nervous system.

Allusion has been already made to the means by which foreign matter is being constantly, but quietly, removed from the pulmonary passages; but these substances, as well as others which result from the secretion of the mucous membrane, are at times more forcibly expelled by a special modification of the respiratory act. Coughing consists first of a deep full inspiration, by which the lungs are filled with air. Then the glottis, or upper orifice of the windpipe, being completely closed, this is followed by a sudden and forcible expiration, which bursts open the glottis and drives out a blast of air. This peculiar action of the muscles concerned is provoked through the nervous system by some irritation in some part of the respiratory passages.

In sneezing, the same essential action occurs, except that, in this case, the communication between the mouth and pharynx is closed, so that the blast of air is driven entirely through the nose.

Hiccough is caused by a sudden inspiratory contraction of the diaphragm, during which the glottis abruptly closes, so that the further entrance of air is checked. The air about to enter strikes upon the closed glottis, and produces the well-known sound.

But owing to the relation in which the respiratory mechanism stands to the nervous system, its movements are, as we have already seen, very easily disturbed, and thus it becomes the instrument of expression in various emotions.

Laughter is produced by an inspiration, succeeded not by one only, but by several short spasmodic expirations, the glottis being freely open, and the vocal chords being thrown into characteristic vibrations.

In crying, the respiratory movements are modified in much the same way, and the two actions are frequently indistinguishable. The facial expression, however, is usually different. Sobbing is due to a series of convulsive inspirations.

A sigh is only a deep and long-drawn inspiration, followed by a somewhat shorter expiration.

In yawning, the inspiration is deeper and longer than in sighing, and the air is drawn, not through the nose, but through the widely-open mouth, the lower jaw being greatly depressed.

It has been mentioned that the windpipe is surmounted by a special structure, called the larynx, which opens into the front part of the pharynx, behind the base of the tongue, and through which all air in its ingress and egress passes. This is the organ of the Voice, and the various sounds which constitute it—the notes of which it is composed—are produced by the vibration of two more or less parallel and exquisitely elastic chords, the tension and degree of approximation of which are regulated by delicate muscles. The active agent in producing vibration of the chords is the current of air forced in expiration from the lungs. The voice is subsequently moulded by the tongue, lips, teeth, and adjacent parts, into language.

In the lungs, then, carbonic acid is removed from the blood, the chief product of the combustion or oxidation of the substance of the food and tissues. At the same time, fresh oxygen is introduced to the blood. Life depends very directly on both these conditions. If either be arrested, death soon follows. When both are hindered, as when persons die from want of breath, the effects produced are due to both causes. The carbonic acid unduly retained becomes an active poison, but perhaps the deficiency of oxygen is more directly concerned in the fatal result.

Another chief product of oxidation in the body is urea, which escapes by the kidneys. This substance largely contains nitrogen, and therefore represents the waste of flesh and of the nitrogenous or flesh-forming substances of food. Rather more than an ounce of urea is excreted daily.

The inorganic salts which are contained in food, and which enter into the composition of the tissues, are carried off mainly by the kidneys, and to a less extent in the perspiration by the skin.

More water escapes by the skin as perspiration than by the lungs in the breath, but the proportion is very variable—from both sources, on an average, more than two pints daily. The greatest amount is drawn off by the kidneys—between two and three pints.

Carbonic acid, urea, inorganic salts, and water—these are the chief substances which have to be carried off from the body, and the means by which they are removed is called the process of excretion. Between the various substances taken as food for nourishment and these stand the blood and the several tissues of the body. The food is converted into blood, and some of it still further into tissue. Then, in the discharge of function and for the production of heat, it is oxidised, and, chiefly in the form of carbonic acid and urea, passes from the system. While the lungs and the kidneys are distinguished each by the large excretion of a special substance, all three, the lungs, kidneys, and skin, are connected by the removal of a common substance, water; and their work in relation to this is vicarious. When more water is carried off by one means, less escapes by another. This relation between the skin and kidneys is recognised by every one. In cold weather, when the skin acts less, the kidneys remove more water; in hot weather, when the skin is active, the kidneys remove less.

But the perspiration is not simply water; other substances, although only in very small amount, are constantly found in it. The chief of these are inorganic salts, such as sodium chloride, or common salt. But there are also traces of urea and of carbonic acid.

The quantity of perspiration, or the amount of fluid lost by the skin, is determined by various causes both from within and from without. The influence of exercise on the action of the skin is obvious to every one. Then the external temperature, the amount of moisture already present in the air, and its stillness or motion, affect the amount of fluid that escapes by the skin. Some of the water forthwith evaporates, and disappears as insensible perspiration, and some at times collects on the surface and bedews it, or even runs off in drops. The amount of sensible perspiration is by no means always in proportion to the total amount which is formed, for the external conditions already mentioned largely determine whether the sweat shall disappear as vapour or collect on the surface.

The evaporation of water from the surface is an important means by which the temperature of the body is reduced and regulated. This will be readily understood when the amount of heat which must be concerned in converting water into vapour is considered. And hence one important effect of clothing. Man is distinguished from animals by his nakedness—by the absence of all means which lessen the escape of heat from the skin—and his clothing in this respect is an artificial substitute for fur and feathers. It not only checks loss by direct radiation, but it also greatly interferes with evaporation.

The sweat is formed by minute glands, which are everywhere thickly set in the substance of the skin. Some fluid may escape by simple transudation through the skin in the intervals between the glands, but we have no means of determining what proportion this bears to the rest. But besides these glands, called sudoriparous, there are others which especially abound in certain parts. These, which are called sebaceous glands, secrete an unctuous substance, which lubricates the surface, and plays an important part in maintaining the texture and properties of the integument. It is this substance upon the surface that causes the difficulty in wetting it thoroughly with water, and that can be removed only by prolonged scrubbing with the use of soap.

Between such substances as carbonic acid and urea on the one hand, and the constituents of certain fluids which are formed from the blood on the other, it will be observed that there is this distinction : the former when separated are forthwith cast out of the body, and are therefore called excretions, while the latter, as in the case of the bile already noticed, are destined to some farther purpose in the economy, and are therefore distinguished as secretions. What may be the ultimate destination of some of these secreted substances, as, for example, of the constituents of the gastric juice and saliva, we do not at present precisely know, but in the instance of the bile, which mainly consists of substances rich in carbon and hydrogen, there is strong evidence to show that these, after playing the part already mentioned in digestion, are re-absorbed, and regaining the blood, are finally oxidised, and by their combustion assist in the production of heat. And with regard to the formation of these various substances which are thus by various organs drawn from the blood, there is this further difference to be noted: that some of them, as carbonic acid and urea, are constantly found in the blood itself, and are only separated from it by the organs through which they are excreted; whereas others, as certain constituents of the bile, do not exist as such in the blood, but are formed out of it by the action of a special organ.

Organs, such as the liver, pancreas, and kidneys, whose office it is then to separate various substances from the blood, are called glands. They are composed essentially of minute bodies, called cells, which are the active agents in the process. The product of the action of these cells is collected into minute channels, which conduct them into larger ones formed by their coalescence, until at length they flow away from the gland through a single tube, or duct. But there are other organs in the body also, unfortunately called glands, which in structure and function differ greatly from these. The spleen is called a gland, but it has a remarkable structure which does not separate any material from the blood, and therefore needs no duct. The glands in connection with the lacteals and lymphatics have been already mentioned. These, which are small and very numerous in many parts of the body, are in structure and function very nearly allied to the spleen, and the great tract of mucous membrane—the membrane that lines the great cavities which communicate with the exterior, as, for examples, the digestive canal and the respiratory tubes—this mucous membrane is in some parts very rich in minute structures set in its substance, which have functions similar to those of the lymphatic glands. The spleen and similar structures are sometimes distinguished by the term ductless glands, but they are better known by their function. They are concerned in the development of the blood. The fact has already been noticed that the lymph, after passing through the glands, is much richer in white cells, and the blood, after leaving the spleen, yields evidence of considerable improvement. The physiology of these important structures has not yet been thoroughly worked out, but enough is understood to justify the title by which they are at present generally known—blood-elaborating glands. The great liver itself, in one of its offices, belongs to this class. In the manufacture of bile it is a secreting gland, but the blood itself is greatly altered in its passage through the liver. By the arrangement of the circulation, all the blood that goes to the stomach and intestines finds its way directly afterwards to the liver. The capillaries of the stomach and intestines lead, as usual, into veins, which collect into larger ones that at length form a single vein; but this, instead of making its way directly to the heart, passes to the liver, through which its blood is distributed, to be again collected into larger veins, which go, with the rest, to the heart. Thus, whatever is absorbed by the blood-vessels from the stomach and intestines—that is, all the substances of the food which have been completely dissolved—are subjected to the action of the liver before they find their way into the general mass of the blood. The blood, then, going to the liver from the stomach and intestines, must be, during digestion, largely charged with crude materials, and when it leaves the liver these have been very considerably elaborated. There can be little doubt that these two great functions of the liver, the elaboration of blood and the formation of bile, are very closely related; that one action is the complement of the other.

The Animal Functions, or the Functions of Relation.—Leaving now the functions of organic life, those which are directly concerned in the maintenance of the individual, and turning to organs of another class, the so-called organs of animal life, or those which minister to the function of relation, let us glance first of all at the Skeleton. No fact in anatomy is so obvious to all as the contrast between the bones and the soft parts of the body. The great hardness of the bones, due to the earthy matter they contain, their passive character to casual observation, and their endurance for ages after all other parts have decayed and disappeared, suggest to many a very false view of their nature. The bones, like other organs of the body, are living structures; like other parts, they are subjected to natural and morbid changes; they exhibit similar phenomena of health and disease; they suffer, as other living structures do, from injury, and are capable, as may be seen any day, of very perfect repair; a broken bone, in favourable circumstances, is restored to its original condition. In truth, the bones, which are in the first instance formed from cartilage, or membrane, belong to the class of tissues, called fibrous; of tissues which are composed of extremely delicate and simple fibres, variously interwoven, such as tendons and ligaments, and that remarkable tissue which is found all over the body, and is so abundant in many parts, which binds together different organs and the proper structures of the same organ, and is therefore called connective tissue. The bones, like these structures, are supplied with blood-vessels and nerves, but, like them, sparingly, in comparison with the more highly-endowed structure of muscles and nerves. The bones owe their most obvious characters to the infiltration of their fibrous framework with the salts of lime in the form of minute granules. About one-third of bone consists of animal matter, in the form of fibrous tissue, and two-thirds of mineral matter, composed chiefly of calcium phosphate and carbonate. When a section is made through the substance of bone, its texture appears to be very different in different parts. At the surface, and for a variable depth inwards, the texture is compact, so dense that to the naked eye it is smooth and uniform, and can be polished like ivory; but in the deeper portion the texture opens out so as to become sponge-like, or cancellous, and the minute spaces thus formed are very visible to the naked eye. The contrast between compact or dense bone and cancellous or spongy bone is usually obvious enough, and yet it is but a question of density. To the microscope, bone everywhere exhibits the same structure; the difference is simply due to closeness of arrangement.

In the shaft of the long bones of the limbs the cancellous tissue rapidly disappears toward the centre, so that there a single cavity is formed, which is filled with a kind of fat, called marrow; but in the interstices of the cancellous tissue everywhere, a soft albuminous substance, marrow of another kind, is found. Different bones vary much in hardness and density. In some parts the compact tissue is almost cancellous, in others it is almost as hard as ivory. The strength of bone, the arrangement of the compact and cancellous portions, and even the plan or pattern of the cancellous tissue itself, is evidently in relation to the degree of resistance required. This is beautifully shown in a longitudinal section through the head and neck of the thigh-bone. The cancellous tissue is here, for the most part, arranged in the form of tiny Gothic arches, rather regularly superimposed, the columns of each arch resting upon the apices of two subjacent ones, and all having a direction corresponding with the long axis of the neck, that is, in the plane through which the lines of greatest force usually pass.

The great strength of bone, its hardness and power of passive resistance, is its most obvious feature, but it has other qualities that are eminently useful, and must not be overlooked. The texture of bone in some parts, as in the spine in front, and about the neighbourhood of joints, is less brittle, or, as it may be expressed, more tough than elsewhere. But all bones are more or less elastic. This property is very conspicuous in the ribs, out of which bows have been formed. But even a skull, if allowed to fall on a stone-floor, will rebound with considerable force.

The quality of bone varies at different periods of life. In infants, many of the bones, before they are fully infiltrated with earthy matter, will readily bend, and sometimes at this age, when they are broken by being bent, they will crack after the fashion of a green stick, only half through, on the convex side. They are stronger during the middle period of life, and in old age they are more easily fractured. It has been supposed that this is due to their increasing brittleness from the loss of animal matter, but it is, at least in many cases, chiefly due to the loss of substance altogether. In those who grow lean and spare in old age, the bones, like other parts, suffer loss of substance. They become lighter, and this lightness means loss of strength. When the bones alter in composition, it is usually by the increase of fat, which sometimes then pervades their texture, and forms a part of that general fatty degeneration and accumulation to which a class, in the decline of life, are prone.

The skeleton constitutes by weight about one-sixth of the whole body, and consists of upwards of two hundred distinct bones. In the first place there is the spinal column, composed of a series of bones very closely and elaborately locked together, and enclosing throughout a canal, in which is lodged the spinal cord. The spinal column gradually increases in size from above downwards. It is not quite straight, but forms a series of alternate curves. In the neck it is very slightly convex forward. In the back it forms a long and rather bold curve backward. In the loins it is again slightly curved forward, and once more below it is bent backward. Although the movement between any two bones, except the two first, is very slight, the whole column is very flexible. Upon its summit is the skull, containing the brain, which, with the first bone of the spine, is capable of very free movement. To the bones of the spine in the dorsal region are appended, on either side, the twelve ribs, the majority of which, extending round to the breast-bone in front, enclose and protect the cavity of the thorax, which contains the heart and lungs. Upon the upper part of the thorax are two bones, forming the shoulder-girdle, to which are attached the bones of the upper extremity. Below, firmly bound to the bones forming the lower end of the spinal column, which have coalesced into one strong wedge-shaped piece, are the two haunch-bones, which enclose a cavity called the pelvis. A deep socket on their outer surface receives the head of the thigh-bone. The upper and lower extremities are formed on a similar plan. The arm and thigh have each a single bone. The fore-arm and leg have each two bones. To these, at the wrist and ankle, succeed a number of small bones, and to these the bones of the fingers and toes. Between the chest and the pelvis is a space not surrounded by bones, called the abdomen. This cavity, which contains the organs of digestion, is separated from that of the chest by a partition composed of a powerful muscle and its tendon, the diaphragm. This muscle has been already noticed as the chief agent of inspiration. If the skeleton, therefore, were bisected longitudinally, either half would show the plan upon which the different cavities it contains are arranged. A comparatively small posterior cavity, forming the spinal canal and the cavity of the cranium, and containing the great nerve-centres, would be separated by a bony wall from a large anterior cavity, containing the whole digestive tract from the mouth downward, and the organs of circulation and respiration.

The joints which are formed between the bones admit of being divided into different classes. In some, as in those of the skull, the bones are very firmly locked together, and there is no movement between them. In others the movement is extremely limited; two surfaces, more or less flattened, glide slightly on each other. In this case, although the movement in any one joint is always within a narrow range, yet when several such joints are close together, as in the instance of the wrist and foot, the total amount of motion may be considerable. But in other joints, the actions of which are more familiar to us, the movements are very free. Sometimes the joint is constructed after the manner of a hinge, admitting only of a to-and-fro movement, but through a wide range. The most striking instance of this is at the elbow joint, between the bone of the arm and one of the bones of the fore-arm. This joint permits of flexion, as when the fore-arm is bent on the arm; and of extension, when it is carried backward and straightened. Then the most complete joint of all, that which admits of the greatest variety of movement, is the ball-and-socket joint, as at the shoulder and the hip. The arm and leg can be carried forward, backward, inward, and outward, can be carried round so that the hand and foot may describe a circle, and, in the case of the arm especially, the limb can be rotated on its own axis. These joints, and that of the thumb, are the most movable in the body. That portion of a bone which enters into the formation of a joint and is called its articular surface, is capped with a layer of cartilage, or gristle, and this presents a smooth and highly-polished surface. The ends of the bones are bound strongly together by ligaments, and more or less supported by muscles, and the surfaces of the bones and ligaments are lined by a delicate membrane which forms a more or less complete sac, or bag, and secretes just enough of a viscid fluid to lubricate the opposed surfaces, so as to enable them to work upon each other with the least possible amount of friction; hence the popular term for it of joint oil. In the instance of certain joints, as those of the knee and lower jaw, an additional structure is introduced to prevent still further any mischief that might arise from any sudden and violent contact of the surfaces. A plate, or layer, of dense tissue, a mixture of fibrous tissue and gristle, shaped in adaptation to the surfaces, is interposed between the bones, where its acts as a buffer. In the case of the spinal column, no actual joints exist between the bodies of the numerous bones which compose it, but between adjacent bones a thick layer of tough and elastic material intervenes. This, although united firmly to the bones above and below, yet allows of some play between them, and the total effect of this arrangement throughout the column is to afford a considerable extent of motion. In the case of joints that are not very movable, the bones which form them admit of being bound together very firmly by strong ligaments; but when the movement is very free, the ligaments, which are not elastic, must be comparatively lax. In the latter forms additional security is given by the support of powerful muscles.

Besides the more obvious purposes of joints connected with their movements, they play, no doubt, an important part in counteracting, by their construction, the effects of shocks and sudden jars. For instance, if one continuous structure extended from the feet to the head, the effect upon the brain of jumping down from a height would be very different from what it actually is, and no one studying the construction of the spinal column can overlook the purpose which is thus secured. In the foot, again, is another admirable example of the effects of a similar arrangement. Between the ankle, heel, and base of the toes there are a dozen bones, and between some of these there is scarcely any perceptible movement. But, as all know, a well-made foot forms an arch when a person stands upright; the whole sole of the foot is not in contact with the ground, but only the heel and the base of the toes. On the inside there is a considerable interval under the arch. Now, upon the summit of this arch the great bone of the leg rests; in other words, upon this point falls the weight of the body. The bones of the foot hereabout are more or less wedge-shaped, so that, after the fashion of a properly-constructed arch, the greater the pressure, the more firmly are they driven together. But beneath, this arch is sustained by very powerful ligaments, and thus in the whole structure there is not only much play, but in transmission the lines of force are broken.

The Muscles, which form flesh, and are recognised as the lean of meat, constitute the great bulk of the solid part of the body; nearly half of the entire weight is due to muscles. There are two kinds of muscle: one, the most powerful and abundant, forming the large masses of flesh, of a deep red colour, comprises the active agents of the sensible movements of the body, as of the limbs. They are attached to the bones, not directly but through the intervention of tendons. Thus they have two points of attachment, between which they act. The more fixed of these is called the point of origin, and the more movable one the point of insertion. These muscles, upwards of five hundred in number, are, for the most part, under the control of the will, and hence are termed voluntary muscles. Their substance is composed of fibres which, under the microscope, exhibit fine transverse stripes: hence, again, these muscles are sometimes called striped, or striated muscles. They are richly supplied with blood-vessels and nerves; in short, they are very highly-endowed structures. But besides these there are muscles of another kind, whose characters are not so obvious.

These, whose existence and action has been already alluded to, are found as a constituent of the walls of various tubes; of the gullet, where they form a comparatively thick layer, of the stomach, of the whole of the intestines, of the smaller arteries and the veins, of gland ducts. They are usually arranged in spiral layers, the external ones more nearly longitudinal, and the internal more nearly circular. They, too, are composed of fibres; but these differ in size and shape from those of voluntary muscles, and they have no transverse stripes. Hence, these are known as plain, or unstriped muscles; or, because their action is not under the control of the will, involuntary muscles. Their office, as already mentioned, is, by an action called peristaltic, to propel onward the contents of the tube.

The heart, as previously stated, is a muscle, but of a somewhat peculiar kind. The fibres are striated, but smaller and finer than those of voluntary muscle, and its action is not under the control of the will.

All muscle, of whatever kind—and other forms are to be found in the lower animals—is distinguished by a remarkable property, which is peculiar to it, and belongs to it only as a living structure. This is contractility, or, as it is sometimes (though more vaguely) termed, irritability. Muscle has, when stimulated, the power of active contraction, of approximating its ends, of becoming shorter, and thus it moves the parts, as the bones, to which it is attached. When a muscle thus acts or contracts, its total bulk is not altered, for what is lost in length is gained in thickness, so that, in action, it swells up and becomes firmer. This change will be at once understood if, while the fore-arm is being bent, the front of the arm above its middle is grasped by the other hand. The lump which is felt is the substance of the biceps muscle during its contraction. This peculiar property of contraction, by which a muscle may be shortened about one-third, is a vital one, for it disappears with the life of the muscle. A dead muscle is rather tough and somewhat elastic, but no longer irritable. The power with which a muscle contracts is undoubtedly very great, but it is not easy to measure it precisely. The following illustration may suffice. The great tendon which is inserted into the heel-bone, the so-called Tendo Achillis, is one of the strongest in the whole body, and this strength is owing to its physical properties. When removed from the body, it has sustained a weight of 2,000 lbs., yet sometimes by the sudden action of the muscles of the calf, to which it belongs, it has been snapped across.

Muscles may be excited to action by various means. In the living body they are naturally excited through the nervous system. An impulse is conveyed along a nerve to a muscle, and it forthwith contracts, and the nerve so supplying it is called, on this account, a motor nerve. But a muscle may be excited powerfully to contract by an electric current. When a living muscle is removed from the body, it may be made to contract by various mechanical stimuli, such as pinching or pricking; but when a portion of a muscle is thus treated, it is observed that the contraction does not involve the whole muscle, but only the part that is stimulated, and perhaps the fibres immediately adjacent to it. Powerful chemical agents and heat will produce like effects. This contractility is a property of the living substance of muscle, and the act of contraction, or the work of the muscle, involves the consumption or oxidisation of a portion of its tissue. After a muscle has been for some time in action, the products of the necessary chemical changes may be collected. A definite relation exists between the amount of work done and the amount of muscle transformed. Heat, too, is evolved during muscular action. When a muscle contracts, its temperature rises a degree or so. During the active contraction of a muscle, sound also is produced, a dull rumbling sound, which has been compared to that of distant carriage-wheels. And, lastly, during contraction changes also occur in the electrical condition of a muscle, but the nature of these changes is not as yet clearly understood.

Muscles are not highly sensitive structures in the ordinary acceptation of the term. When the skin is divided, far more pain is felt than when a muscle is cut, yet, nevertheless, the voluntary muscles are in very close and delicate relation with our consciousness. A very fine perception of their exact state and degree of contraction must be a necessary condition of our control and direction. That minute adjustment of force which we are enabled to apply to any desired end must depend on the existence of what has been called a muscular sense. It is through this, for instance, that we are able to appreciate the weight of a body. When we hold anything in the hand, we judge how heavy it is by the degree of force required to sustain it, and our estimation of this must be by a subtle consciousness of muscular effort.

It is probable that almost all our voluntary actions involve the contraction of more than a single muscle, oftentimes of very many. And in anatomy, muscles are classified into groups, according to the general direction in which they act. Thus, there is a group of muscles in front of the fore-arm called flexors, which act upon the hand and fingers, and another group behind, their natural antagonists, called extensors. Besides these, in the hand itself, there are nineteen muscles; in the sole of the foot an equal number. While each of these and every other muscle of the body has some action peculiar to itself, in its ordinary work, it is, no doubt, for the most part, associated with others.

This harmonious combination of groups of muscles in various actions is accomplished by the nervous system, and in relation to this, it is interesting to note that muscles which are accustomed to act together are often supplied by branches of the same nerve-trunk. Much depends, therefore, in our various movements, not only on our power to direct and control the action of any particular muscle, but also on the power we possess of combining several muscles in their action for any given purpose. This power of co-ordination, as it is called, is very greatly strengthened by practice. Certain movements that involve the combination of several muscles can, at first, be accomplished only with considerable difficulty, but, by practice, the muscles at length get into the habit of acting together, and by-and-bye it may become almost as difficult to disassociate them.

The great majority of the muscles are attached to levers which are formed by the bones, and in the body there are instances of each kind. The movement forward and backward of the head upon the spine, as in nodding, is an instance of the first kind of lever. The fulcrum between the weight and power is at the articulation; the weight is the head and face in front, and the power the muscles at the back of the neck. The muscles that depress the lower jaw and open the mouth act on levers of the second kind. The fulcrum is behind, at the joint, the power is attached in front, and the weight or resistance lies between them. The action of the biceps muscle on the fore-arm is an obvious instance of the third kind of lever. Here the fulcrum is at the elbow-joint, the weight at the hand, with whatever may be in it, and the power between the two, just in front of the fulcrum.

Muscles frequently act on levers of the third kind; that is to say, so far as power is concerned, at a mechanical disadvantage, and in some of these instances the power is so near the fulcrum, and the weight is so distant, that the disadvantage must obviously be very great. But then it should be remembered that what is lost in force is gained in velocity, so that here is no evidence of wasteful expenditure of strength.

Elastic tissue plays an important part, and an economical one, too, in certain movements, and this simply by means of its physical property of elasticity, which it possesses in perfection. This elastic tissue is, of course, passive until either extended or compressed by some force, and this force is usually muscular action, when, as the force is remitted, it recoils with proportionate power. Thus, its use is commonly considered in relation to muscular action. It may either assist muscular action, be accessory to it, or it may be opposed, acting in the contrary direction. Elastic tissue is usually rendered active by stretching; sometimes, however, it is compressed. As illustrations of these several modes and purposes of action, may be mentioned the elastic structures connected with the bodies and plates of the bones of the spine, the elastic wall of the arteries, and, above all, the vocal chords.

Furthermore, structures adapted to motion are so provided that movement shall occur with the least possible amount of friction or loss of force. As already stated, the joints are lined with a highly-polished membrane, and provided with an unctuous secretion for this purpose. Tendons of muscles also play in sheaths of similar construction, and so glide smoothly on each other without friction ; and the great organs of the body which are subjected to constant movement, the heart, the lungs, the stomach, intestines, and other abdominal viscera, and even the spinal chord and brain—for the brain has distinct, though slight, movements dependent on its circulation—these chief organs are enabled to glide without friction on the walls of the cavity in which they are contained, by an arrangement similar to that which prevails in the joints. The delicate, highly-polished membrane which invests them, and which is continued without interruption on to the opposite wall, secretes just enough of a watery fluid to keep its surfaces moist. These great serous membranes, as they are called, engage a large share of the attention of the physician and surgeon, on account of their liability to disease and especially to various forms of inflammation.

One of the chief characters of man, that by which he is especially distinguished from all animals, is the high degree of development of his Nervous system. This system, which in some form or another may be detected in all animals, save the lowest and simplest, appears at first, of course, in a very rudimentary condition, and it is only by tracing it from below upward, and studying the successive steps of its evolution, that we are enabled, at all adequately, to interpret its physiology in man.

In structure and function two distinct parts may be recognised in the nervous system; the nerves, which are cords composed of bundles of fibres, and masses of nervous matter called centres, which, in addition to fibres, contain cells with which the fibres are connected. The nerve fibres, which by their aggregation into bundles form the nerves, are comparatively simple structures. They are composed of an almost transparent, semi-fluid substance, contained in a sheath. The so-called nerve-cells, which are sometimes regular and spheroidal in shape, sometimes very irregular, with branching processes, are composed, too, of a structureless substance, some form of protoplasm. The continuity between the fibres and cells may sometimes, but not always, be distinctly traced, and the so-termed branches of some of the cells are probably the remains, or ends, of the fibres in connection with them which have been broken off. Now, the presence of aggregations of these cells, besides the fibres, gives a distinct character to nerve substance which then forms a ganglion, or nerve centre; so that the nervous system consists of nerves, which are only fibres, and of nerve centres, which always contain, as an essential part, nerve cells. Owing to the presence of these cells among the fibres, nerve centres, or ganglia, may usually be at once distinguished from nerve cords by their shape, and sometimes by the aggregation of several centres into one mass, organs of great size and of still greater importance may be formed. Thus, for the chief examples, the human brain and spinal cord are constructed.

Now let us glance at the constitution of the Nervous system.

In one of the simplest forms in which it appears in some of the lowest animals, it consists of a single ganglion, or centre, with two cords, one extremity of each of which passes into the ganglion, while the other is distributed to different parts.

The first step onward in the progress of the nervous system is that the centres are repeated, and the number of cords proportionally multiplied. The ganglion is no longer solitary, but we find another and then another, until by repetition many appear. The ganglia, as they thus become multiplied, vary in their position; they are either regularly placed, as in a beetle, or irregularly, as in an oyster. This, their relative arrangement, is of little or no importance to their physiology. It, however, must be remarked that when the centres are thus multiplied they are found to be not only connected to cords which are distributed to various parts, but also, by means of other cords, they are connected, in most instances, directly with each other. These latter cords, which are distinct from those of distribution, and establish a direct relation between different ganglia, are called commissures.

The next step in advance, which is almost coincident with the former, is that certain ganglia manifest functions different from those of the rest; they have peculiar or special offices. The principal of these special ganglia are immediately connected with the organs of special sense.

Lastly, these several ganglia, thus variously distributed, are brought into still closer relation. They coalesce, so that compound ganglia are formed. Thus, a nervous mass, apparently simple, may consist of several really distinct ganglia, which have thus become blended. The plan of this coalescence is beautifully shown in the metamorphosis of insects. Even here the primary ganglia are still connected only by fibres or commissures, so that, whether ganglia are visibly distinct and separate, being connected only by long commissures, or whether, coalescing, they are brought into connection by shorter commissures, is not a difference of such import as it might at first sight appear to be.

Therefore, in man, in whom the nervous system is found to be most highly developed, we trace, in a remarkable manner, the result of these several steps of progress. Large, highly-developed nerve-centres—the spinal cord and brain—connected with very numerous cords; in their nature compound, being formed, as comparative anatomy and their own development show, by the coalescence, more or less complete, of many distinct centres. Some of these are endowed with special offices. And with all this evidence of an advanced state of development, the nervous system, in relation to the several functions of the body, rises to a condition of supreme importance.

The spinal cord, lodged in the spinal canal, forms one long continuous mass, from the sides of which numerous nerves spring in regular succession. Above, it terminates in a somewhat expanded portion, called the medulla oblongata. This, and, through it, the spinal cord also, is connected with various ganglia situated at the base of the skull, and these are surmounted by the largest masses of nerve substance of all, the brain proper, or the cerebral lobes.

It may be mentioned that, in each of these several centres, two kinds of nervous matter may be recognised very easily by their colour, the white and the grey. The white consists for the most part only of fibres, but the grey matter is composed chiefly of cells. In the spinal cord, the grey matter is in the centre surrounded by the white; but in the brain the grey matter is found on the surface, where it is arranged in the form of numerous complex folds, which are called convolutions.

Now the cords, the anatomical elements of which are fibres, and the centres, the anatomical elements of which are cells, differ greatly in their function.

If one end of a living nerve-cord be irritated, an impression of some sort is conveyed to the opposite extremity. Such an impression is sometimes called a nervous impulse; but what happens to the cord we do not know. Like telegraph wires, the nerves do not betray by any external sign that news is speeding along them. Like these wires, in order to be fit for service, they must be entire; and, in some other respects, the transmission of such an impulse is analogous to a current of electricity, and to this it has often been compared; but it is certainly not altogether identical with it, for it differs from it in some important respects. Some form of molecular disturbance in the nerve-fibre is assumed, and probably upon good grounds. The fact, however, is clear that the function of these fibres is the transmission of impressions. The nerve-centres also, and this by virtue of the fibres they contain, can conduct impressions, but they have other and higher offices by which they are distinguished.

When an impression is conveyed by a nerve to a nerve-centre, this may dispose of it in various ways. It may reflect it. Now this reflex action appears to be the chief; it certainly has been the most fully studied, and is the best understood of the functions of a nerve-centre. By reflex action is meant the power which nerve-centres possess of receiving and perceiving an impression brought to them by a nerve from some part, and, as the result, of transmitting an impression through another nerve to some other, it may be distant, part. Thus an impulse conducted by nerves from without inward, reaches a centre, and by that centre, as the result, an impulse is sent through other nerves which conduct it from within outward. So, it is said, an impression or impulse is reflected by a nerve-centre. If, for a familiar instance, the skin be pricked, the part is suddenly withdrawn. An impression is conveyed from the spot injured through a nerve to a nerve-centre, and hence another impression is sent by the centre through another nerve to muscle, which then contracts and moves the part away.

But although in this instance, of course, pain or sensation—or, in other words, the consciousness of the impression—is concerned, neither sensation nor, still less, any idea, is necessary to the performance of a reflex act, and whether or not such states shall accompany it depends on the centre through which the action takes place. There can be no doubt that those reflex actions which are of most general occurrence are accomplished without the intervention of idea or consciousness, and these, the simplest form of reflex action, are conveniently distinguished by the term excito-motor, which is meant to imply that muscular contraction, or some other result, is the effect of a simple excitation of a nerve-centre.

Numerous actions that are continually occurring in our bodies, and in those of the higher animals, afford examples of this kind of reflex function. These, from their very nature, being unattended by consciousness or sensation, escape observation. Without entering further into detail, it may be said that the contraction of plain or unstriped muscles generally is thus excited. That powerful and violent reflex acts may occur without idea or consciousness of them is proved in innumerable cases of disease and accident, where, from some injury to a portion of the spinal cord, the communication between some parts of the body and the higher nerve-centres is cut off. In these parts, the most lively movements will often occur, and these are not only beyond the unfortunate person's control, but continue without the least consciousness, unattended by the slightest sensation. That any given movement is adapted to a particular end is no proof that it is not the result of simple excito-motor action. It must not be assumed that the obvious adaptation of a movement to a definite purpose is in itself evidence of the operation of will or the intervention of consciousness; for a passing consideration of some of our own functions will at once suffice to refute such an idea. For example, what movements are more obviously adapted to a definite purpose than those of the muscles of respiration? yet we know that neither the will nor even consciousness is necessarily concerned in them, for they work efficiently during the profoundest sleep.

But next there are actions of a reflex character which produce sensation, involve consciousness, but which are nevertheless involuntary, not only occurring independently of the will, but often in direct opposition to it. Of these actions, which are conveniently termed sensori-motor, there are in ourselves some striking examples. An excellent illustration may be witnessed in the movements and laughter excited by tickling. Here very unequivocal sensations are produced. We are fully conscious of the impressions, and we struggle and laugh involuntarily, even in spite of the will. Coughing, again, is usually another act of the same kind, and many more might be mentioned.

Now, a question comes in here that is too interesting to be put aside in silence. Why are certain acts thus attended by sensation? Why, unlike the former ones, do they involve consciousness? More than one beneficent purpose is thus attained.

Danger is thereby avoided. For example: if some irritating gas or vapour be drawn into the commencement of the air passages, we at once, by the sensation it produces, recognise its presence, become conscious of the evil, and forthwith adopt means te get rid of it. The very unpleasant subsequent effects of the injudicious application of irritant substances to the nostrils during faintness or insensibility is just a hint of what might otherwise occur. Hence an all-wise design of pain, by which we are warned of the advent of mischief, of the stealthy progress of disease in time either to adopt measures to avert it or to prepare to meet its consequences.

Again, through sensation and consciousness our daily and hourly acts are sources of pleasure; acts, be it observed, which are necessary to life and health. Thus, when food is required we become sensible of the want, and its proper supply affords enjoyment.

But hunger and thirst, although distinctly sensations, are yet in a measure peculiar. They are produced through particular nerves, and more or less localised to the region of the stomach and throat, and are suggestive of particular ideas. There are other and still further modifications of common sensation. The sense of touch is closely akin to it, yet not identical, for in the skin, over the whole area of which the sense of touch plainly exists, there is by no means in every part a direct relation between ordinary sensibility and the sense of touch. The sense of touch is especially acute, for instance, about the tips of the fingers, but other parts of the surface, as the eyelids, are more sensitive to pain. Moreover, anatomy discovers in the substance of the skin certain conical structures, called papillæ, connected with the extremities of nerves whose function is clearly the sense of touch. But it should be observed that the evidence derived from handling various bodies is not solely due to the sense of touch. It is usually assisted by movement and by pressure: in other words, by sensations derived from muscular actions.

In taste sensation is still more highly specialised, but between taste and touch no abrupt line of demarcation appears. The papillæ of the tongue are formed after the fashion of the papillæ of the skin; they are more highly-developed structures of the same kind, and the tip of the tongue is the most delicate instrument of touch of the whole body. The sense of smell is closely allied to that of taste, but differs from it inasmuch as while the nerves of taste are conductors of ordinary sensation, the special nerve of smell, like those of sight and sound, conveys only an impression of a peculiar kind. The reflex act of sneezing, however, is provoked through nerves of common sensation. Then, finally, there are those forms of sensation which are emphatically called special; the special senses of sight and hearing. In either case there are special nerve structures, the essential part of an elaborate apparatus, which receive impressions, and these are conveyed by certain nerves to special centres, where such impressions are recognised in the one case as light and in the other as sound.

Lastly, there are impressions which not only produce sensation and consciousness, but which go still further, and excite ideas, and, as the result of these, certain acts are performed, for the most part, in obedience to the will. These voluntary acts that involve ideas have been conveniently termed, in contradistinction to the others, ideo-motor actions.

All these terms, it will be observed, assume motion to be the outcome of the reflex act, and in truth this is usually the most obvious one. Yet the result need not always be expressed in muscular movement. For instance, when food is introduced into the mouth, saliva flows. This is the result of reflex action. An impression is made by food on the nerves of the tongue and other parts; this is conveyed by them to certain centres, which reflect it, through other nerves, to the salivary glands, and so they are stimulated to secrete. It will be seen that reflex action in any of its forms involves the transference of impressions by nerves in opposite directions. An impulse is, first of all, conveyed by one nerve from without inward, centripetally, and then an impulse is conveyed by another nerve from within outward, centrifugally. Hence, the nerves themselves are usually divided into sensitive and motor ones. But these terms are objectionable in more than one way. In the first place, as we have seen, sensation need not always be concerned, and the result of the act may not be motion, at least in the ordinary sense. But no other terms hitherto suggested are wholly free from objection, and these may, for the present, be usefully retained.

The next question is, Through which centres are these several kinds of reflex actions accomplished?

The spinal cord and the medulla oblongata, which, as already stated, is a continuation of the cord, and corresponds to the rest of it in the character of its functions, is the centre of the simplest form of reflex action—excito-motor.

For, if the communication between the cord and the centres above it be interrupted so that any impressions which reach the cord can be no longer conducted through it to them, then they are not felt. The person is now not conscious of them. But, still acting on the cord below as a centre, powerful reflex movements may be produced, that are therefore simply excito-motor.

The surpassing importance of the medulla oblongata as a nerve centre is due to the fact that it contains the ganglia, which are connected with the acts of respiration and deglutition; upon the integrity of these centres the vital function of respiration depends. The medulla oblongata, like the rest of the cord, is always more or less active. Its complete and prolonged repose would obviously be incompatible with life.

There can be no doubt that it is the office of certain centres above the spinal cord and medulla oblongata to produce sensations, and to them impressions must be conveyed in order that they may be felt or perceived by the mind; and it has been rendered highly probable that certain centres which lie at the base of the brain proper—that is, betweeen the medulla oblongata and the cerebral lobes—and with some of which the nerves of special sense are connected, as those of sight hearing, smell, and taste, are the centres of sensations of various kinds, and of sensori-motor actions, constituting collectively what may be called the sensorium.

Acts which are properly called instinctive are essentially of this nature. The purely instinctive acts cannot be said to be the result of reason. There is no evidence in them of the necessary intervention of ideas. It cannot, for example, be contended that, on the part of an insect in some of its most wonderful acts—say, of a bee in the construction of its cell, or of an ant in the storing of its food—there is an intentional adaptation of means to ends, founded on definite ideas of the nature of both; in other words, a calculation of consequences. But this tempting subject cannot be further discussed here.

When impressions are conveyed beyond the centres just alluded to, still farther upward, to the cerebral lobes or hemispheres, results of another order are produced. Ideas arise, and hence the various intellectual functions and consequent acts, which have therefore been termed ideo-motor, or, because of the will, voluntary.

It may be mentioned here that there is good reason to believe that impressions from without can only act on the cerebral hemispheres through the intervention of the sensorium, whilst, in like manner, acts resulting from the exercise of the will can only be effected through the sensorial centres to which an impulse is sent from the hemispheres above.

Underneath the back part of the brain proper there is a considerable mass of nerve-substance, called the cerebellum, or little brain. Of this, it must suffice to say that weight of evidence inclines to show that the greater portion of it is engaged in the co-ordination of muscular movements.

It is well known that if an impression be made upon a sensitive nerve in its course, the sensorium, perceiving that impression, refers it, not to the part of the nerve which is excited, but rather to its periphery, to the part to which those fibres that have been impressed are distributed. A familiar illustration of this is presented in the case of the ulnar nerve, at the elbow. When this nerve, popularly called the "funny bone," is there struck, pain is felt, not so much at the elbow as in the last two fingers, the parts to which the fibres are principally distributed. And so, again, is to be explained the well-known fact, that for years after a limb has been amputated, the person will be conscious of sensations in the hand or foot which was removed, when from any cause the nerves in the stump are excited. Now this applies to an impression made upon any part of a nerve, even to its termination in a nerve-centre. If the central extremity of a nerve be impressed, still the impression is referred by the conscious mind to the distal extremity—to its periphery.

This fact affords a key to the interpretation of what are called subjective sensations. If the central extremity of a nerve be excited, the impression is referred to the periphery, and we naturally believe that the part to which the sensation is referred must be the one which is impressed. Thus, if a ray of light fall upon the retina, the periphery of the optic nerve, it is forthwith conducted to the optic ganglia in the sensorium, and there recognised. But if the central extremity of the optic nerve in the sensorium be excited, the conscious mind still refers the impression to the periphery—which impression, by the way, is always that of light; for any impression, of whatever nature, made upon the optic nerve is perceived only as light, no nerve-fibre seeming to possess the property of transmitting or evoking more than one kind of impression. This is, therefore, what is called a subjective sensation. An impression is made within, and the same effect is produced on the sensorium as if the impression had come from without. The sensorium itself cannot draw the distinction. It must be effected by the mind reasoning by the aid of collateral circumstances. Thus, the vision of the dagger was a subjective sensation in the troubled brain of Macbeth —"a dagger of the mind."

It has been already mentioned, in reference to the function of the spinal cord, that a nerve-centre may conduct impressions like a nerve, and, either with or without itself dealing with them as a centre, may transmit them to other centres beyond. Out of this fact, in connection with the preceding one, some curious conditions arise. Suppose some nerve be excited, the impression will be conducted to a centre, and from this centre or portion of a centre at which it first arrives, it may be transferred to some other centre or portion of a centre, where the central extremities of other nerves, which are distributed to other parts, terminate, and these being thus excited, the impression is referred by the conscious mind, according to the law just mentioned, to their periphery, to the part to which they are distributed, and thus an impression arising in one part of the body may be referred in this way to another part. This is the explanation of the circumstance with which surgeons are familiar; that, at the commencement of disease of the hip-joint, pain is oftentimes felt by the patient in the knee. So, in the same way, disease in one tooth may provoke pain in another, and it has sometimes led to the unpleasant mistake of extracting the wrong tooth.

Again, it appears that some nerve-centres can exercise a restraining influence over others, holding, as it were, their action in check. The brain, for instance, seems able, in certain cases, to exert this inhibitory influence, as it has been called, over the reflex action of the spinal cord.

And closely allied to this power is probably that through which numerous impressions of various kinds that reach the centres produce no sensible result.

One further question of great importance must be asked in reference to the functions of these nerve-centres. In what has hitherto been said of them, they have been described as acting in response to some impulse received or impression conveyed to them from without. Can they act independently of this? At first sight it would appear to be very easy to answer in the affirmative, but the question is beset with difficulty. In certain cases, the spinal cord would seem to excite the contraction of muscles as an original act, but there is strong evidence to suggest the fallacy of such observations, and much to show that its natural mode of action is reflex. For the medulla oblongata, again,—which, as already mentioned, contains the centre of respiration,—there is some evidence in support of the view that, independently of any impression from the lungs, it can originate impulses which provoke the respiratory act. And at present this is current doctrine. So, again, the general belief is in favour of this so-called automatic action of the higher nerve-centres. Certainly, as we go higher, the evidence accumulates in favour of independent action; at all events, of action independent of any immediately preceding impulse from without. But then the question comes in with especial force here—How far are these higher centres capable of storing impressions they receive, and of using them in the discharge of function, after an interval more or less prolonged? Such a suggestion is not altogether opposed to evidence. The simplest form of reflex act consumes more time than does mere conduction, and many of the higher or more complex forms of reflex action involve a more elaborate circuit than the lower. It needs hardly to be added that in the brain itself, and in the operations of the mind, this and almost all difficulties that beset the investigation reach their climax; and it is here especially far more easy to urge valid objections to any view set forth than to advance a step on firm and secure ground.

One fact, however, yet unnoticed, seems tolerably clear. These great nerve-centres are symmetrical. By a longitudinal section they may be divided into two equal and similar portions. But farther than this; the facts of comparative anatomy, and their own plan of development, go to show that each really consists of two portions, or of a right and left ganglion, which subsequently become more or less blended together. Even in the spinal cord evidence of this arrangement still persists in the form of two grooves, or fissures, in the mesial line, one in front and another behind. These nearly meet, so that the halves of the cord are connected together only by a thin strip of nerve-substance. Higher up, the two portions become still more distinct, and the grey masses on either side are connected only by bands of white fibres. In the brain, the cerebral lobes, or hemispheres, as they are often called, are quite distinct, and their opposed surfaces are not even in contact, and at their base only they are connected by a layer of white fibres. Thus, the brain is double, although the mind is single, and if it be assumed, as it generally is upon strong grounds, that the functions of the two halves for the most part correspond, then it must follow that they work in perfect harmony. As, for instance, with the sense of sight, although we have two eyes, we see objects singly; so with thought, although we have really two brains, there is during health no sign of discord or confusion. This harmonious action is referred to the bands which unite the lateral masses of ganglia, and which are therefore called commissures.

The brain and spinal cord, with the numerous nerves that enter into or issue from them, constitute what is called the cerebro-spinal system, because there is another much smaller system, called the sympathetic, which, however, communicates freely with the first. The sympathetic system consists of a series of small centres, or ganglia, situate on either side in front of the spinal column, varying in size and shape between an oat and an almond, from which spring very fine and delicate nerves, whose principal destination is the muscular tissue of the smaller arteries, the contraction of which they control, and thus regulate their calibre. Hence, these are termed vaso-motor nerves.

So, then, speaking of the brain and spinal cord, it appears that the spinal cord is not merely a conductor, or channel, through which impressions from without pass to the higher nerve-centres, and from within from the higher nerve-centres to various parts of the body, but that it is itself the centre of that form of reflex action which is called excito-motor; and that the brain, commonly so called, which includes not only the cerebral lobes but other centres beneath them, that the brain is the organ of consciousness and intelligence, of the emotions and passions, of ideas, of the intellectual faculties—in a word, of the mind.

Yet, with many, there is still a strong—if not strange—repugnance to the admission that mind holds the same relation to brain as function holds to structure elsewhere. Many shrink from the conclusion as if it involved something dangerous or improper. Why? Perhaps chiefly because of the confusion which exists in the conception of mind and soul, a confusion which has always prevailed, even to such an extent that by the best known authors the terms mind and soul appear to be employed indifferently.*

And hence it has arisen that when the mind is spoken of, the soul, or spirit, is assumed to be included, and then the terrible charge of materialism is hurled at those who regard the mind as a function of the brain; nay, so deeply rooted and widely spread is the confusion, that even when the distinction has been drawn it has not been recognised, and passion and prejudice have too often usurped the place of evidence and reason.

A question of this nature, however, is not to be settled by intuition or feeling or rhetoric, or by any appeal to the imagination or desires. Like every other of the kind, if it be a legitimate subject of enquiry at all, it must be determined by evidence. It is not what we think it ought to be, but what we can discover it to be.

This jealousy of research and haste to denounce evidence, not on its merits but because of its assumed tendencies, surely suggests but a feeble faith in the truths which are supposed to be assailed. We say assumed tendency, for what evil of any kind lies in it beyond the disturbance of preconceived ideas? Is the conception of life really ennobled by the hypothesis of a vital principle? Can any evidence of the origin of man touch the question of his destiny? Is the mind less a fact or a force; are its powers lessened; or, if you will, is its supremacy challenged if it is demonstrated to be the function of the brain? If the mind, or the intellectual part of man, is distinguished from the soul, or the spiritual part, the objection urged in the term materialism loses all its force.

But it has been said that the soul and the mind are not distinct. Yet, however difficult or impossible it may be to define them, to understand either, or to disentangle the one from the other in their operations, still in their essential nature they cannot be the same. It is not always easy to avoid the confusion, or to study them apart, because they habitually work together and mutually influence and react on each other. But union is not identity, and their combination in one being does not prove that they are even allied. At all events, in common intercourse, the distinction is practically assumed. For example, we distinguish between the moral and intellectual qualities of a man; between a clever and a good, or a stupid and a wicked man. Thus, in a vague sort of way, the difference is accepted, and how far it may be practicable to define it more sharply and accurately need not be considered here. But that it cannot be defined is no proof whatever that it does not exist. No one contends that mind and body are the same, yet how often, even here, in attempting the analysis, do we pass into confusion? How difficult, nay, impracticable, is it, in many instances, to distinguish the operation of one from the other, even here where the problem offers conditions far more favourable to success? No wonder, then, that the spiritual should be confounded with the intellectual part of man. Yet, although they work and are, so to say, blended together, the phenomena they present to us can be explained only by the fact that they are not one and the same. Do the moral and intellectual qualities of a man go together? On the contrary, do we not often observe in the same individual an almost complete absence of one, and the highest degree of development of the other? How can this be accounted for, except on the assumption that they are, in their nature, different?

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* Thus, in one of his essays, Addison says—

"I consider the human *soul* without education like marble in the quarry, which shows none of its inherent beauties till the skill of the polisher fetches out the colours, makes the surface shine, and discovers every ornamental cloud, spot and vein that runs through the body of it. Education, after the same manner, when it works upon a noble *mind*," &c.

Again, Burke writes—

"On a review of all that has been said of the effects as well as the causes of both, it will appear that the sublime and beautiful are built on principles very different, and that their affections are as different: the great has terror for its basis, which, when it is modified, causes that emotion in the *mind* which I have called astonishment: the beautiful is founded on mere positive pleasure, and excites in the *soul* that feeling which is called love."

"Eloquence the *soul*, song charms the sense."—*Milton.*

See also the quotations under the words *mind* and *soul* in Johnson's Dictionary. But his description is singularly clear and accurate—

"Mind.—The intelligent power."
"Soul.—The immaterial and immortal spirit of man."

The confusion between *mind* and *soul* is still further increased by the word *spirit*, which besides, in other senses, has been and is employed by writers of authority, sometimes for the mind, or intellectual being, and sometimes for the soul.—*See*, *e.g.*, Latham's Dictionary—*Spirit.*

Again, in what are strictly qualities of mind, men and animals differ, not in kind, but in degree. There are the same faculties, although most variously developed. There is, at least in the case of the higher animals, the same combination of instinct and reason, although in relative proportion, in some instances, reversed. But only in man is superadded the moral sense, that which brings him into relation with things which transcend his senses; which are above and beyond them.

Therefore, insisting on this distinction, and regarding the soul or spirit as out of the reach of this enquiry, and speaking of the mind as the sum of the intellectual faculties (for, to avoid still further confusion, the passions and emotions are here left out of consideration), using the word mind in a strict and limited sense, then there are no grounds whatever for assuming the mind to be a principle, or whatever else it may be called, merely resident in or connected with structure in any special or peculiar way, any more than there are valid grounds for belief in the existence of the once-celebrated vital principle; but there appears to be no other conclusion left to rational inquiry than to regard mind as the function of the brain, or, if the expression be preferred, the brain as the instrument or organ of the mind.

For all we know tends to assure us that mind holds the same relation to brain that function holds to structure elsewhere. Evidence similar to that by which the relation of function to structure in other instances is shown, exists to show that the same relation exists between mind and brain, while there is no valid evidence whatever to suggest that the relationship in this case is of a different nature.

Here, just as elsewhere, function depends on structure. There is no sign of function apart from or independent of structure. Whoever witnessed or expects to witness any manifestation of mind in the absence of brain? Exercise of function involves change of structure. Just as the movements of the body involve waste and the repair of muscle, so do the operations of the mind involve waste and repair of brain. In either case the products of waste can be collected, and the sources of repair are known. With improvement or impairment of structure, there is corresponding improvement or impairment of function.

No organ of the body illustrates so strikingly as the brain the subtlety of this dependence of function on structure. Here, for the most perfect performance of function, there must be the most perfect health of structure. No organ, for instance, so rapidly or obviously as the brain reveals by disturbance of function any mischief in the blood which supplies it. Of all organs, this is oftentimes the most delicate test of any impurity of the blood. Witness the effect of alcohol, or of any excess of carbonic acid, or the delirium of fever.

Here, as elsewhere, the same effects are produced by exercise and rest. What organ, by its function, speaks more plainly of fatigue from excessive exertion? What organ, when overworked, asserts more imperatively its claim to rest? What organ, through its function, yields such satisfactory evidence of improvement by healthy exercise, of increase of power by due and proper use, or of degeneration and decay as the penalty of idleness.

The existence of the cerebral lobes is essential to the manifestation of volition and intelligence. When these are removed, an animal, upon the application of appropriate stimuli, will still execute various movements to a definite purpose, for the machinery of all the necessary and usual bodily movements is still present, but an external stimulus is now needed to evoke them. The power of originating or controlling action, of calling the machinery into play or of checking it, is wanting. By the removal of the cerebral lobes, will and intellect are abolished, but otherwise, no loss of function or faculty can be discerned, for the senses, such as sight and hearing, and all those acts that are called excito-motor and sensori-motor and co-ordination of movement, are preserved. Such experiments, then, point clearly to the conclusion that the functions of the cerebrum are eminently psychical in their nature. It must be added that, in our opinion, these conclusions have not been overturned by the results of more recent experiments, the deductions from which are themselves open to very grave objection.

The results of cerebral pathology are more conflicting and less trustworthy than even those of experiment. As Froude has said of History: "It will provide you with abundant illustrations of anything which you wish to believe." Still, it may be fairly affirmed that, on the whole, the results of clinical and pathological observation afford considerable support to the current view of the function of the cerebral lobes.

The facts of comparative anatomy afford the firmest support to the conclusion that the cerebral lobes are the organ or instrument of the intellectual powers and the will—in short, of the mind. A comparison of the structure and degree of development of the brain with the intelligence or mental endowment of different members of the animal kingdom establishes the fact. No doubt the inquiry is open to numerous sources of error, presents many difficulties, has been hitherto very imperfect. And this especially from our want of information of the degree to which intellectual power is developed in any given animal; from confusion and uncertainty of our knowledge on the fact of its manifestation. Witness, for example, what is still often said and written concerning instinct and reason. Still, with all this, and making full allowance for it, there is ample justification for the assertion that, throughout the wide survey which has been taken, a very constant relation has been observed between the development of the cerebrum and general intelligence; that, with increasing complexity of the higher nerve-centres, there is increasing variety of the intellectual powers; and that this relation between development of structure and mental endowment may still be traced through the several varieties of man—a truth which perhaps finds rather strong expression in the popular periphrasis of a fool as a fellow "without brains."

As would, therefore, be expected, the brain of man is remarkably large. Although many animals are much larger than man, the weight of the human brain is found to be absolutely heavier than the brain of any of the lower animals, except the elephant and whale. In relation to the body, the preponderance of the human brain is still more strikingly marked. But, in speaking of the brain in this comparison, it must be borne in mind that the whole encephalon is referred to: not only the cerebral lobes, but the entire contents of the cranium. This, therefore, fails to mark the point to be insisted on with sufficient emphasis. The brain of man—the whole encephalon—is not only remarkable for its absolute and relative size, but also for the far greater development of the cerebral lobes in proportion to the inferior ganglia within the skull. The encephala of other animals owe a much larger proportion of their weight to the other ganglia, and so it comes to pass that in some of the smallest animals the encephala are relatively heavier than in man. In man especially the cerebral lobes tower far above the rest. If, therefore, we compare the cerebral lobes only, excluding the rest of the encephalon, the superiority of the human brain as the organ of the mind is more precisely and far more strongly marked.

Vital Sympathy.—Life, then, in such a complex body as that of man involves the performance of many distinct and various functions by different structures, or organs. But in order that these functions, by which life is here represented, may minister, as they do, to one common end, they all must work in harmony. Therefore, a communication or relation between the several structures and organs must be established, so that the state of any one may influence the rest; so that while each has a special function of its own, its operation may, within wide limits, be made subservient to other functions which are associated with it. This capability of mutual adjustment, this correlation or co-ordination of parts, is well expressed by the term sympathy. It may be said of all animals which consist of separate parts or of individual structures or organs, that there is, as a necessary condition of their welfare, a sympathy between the parts, or organs, which compose them. And, furthermore, it may be observed that as the complexity of the whole body increases, as the diversity of parts becomes greater—that is, as the grade of development becomes higher—or as the several functions become appropriated each to a special organ, so, as the necessary result, does this sympathy or mutual dependence become more thorough, more intimate and intense. In man, therefore, this sympathy is carried to the extreme, and in him it is difficult to select illustrations of it, only because they are so manifold. Witness only the sympathy between the skin and lungs, between the brain, heart, and stomach, or between the eyes.

Now, by what means is this sympathy established? That it is through the nervous system is one of the most familiar facts in physiology. This establishment of harmony between divers parts and their functions is the largest, the universal office of the nervous system, and it depends on those properties which have been already pointed out. In the lowest and simplest forms of life in which a nervous system can be demonstrated this appears to be its only function; at all events, it is the only one that can be at present clearly made out. As the special arises out of the general, and particular portions of the nervous system become endowed with particular functions, this internuncial office, as it has been well termed, is still the most general one; until even in the highest forms of life, in man himself, where special nerve-centres attain a position of supreme importance, this, the earliest and ever the widest of the functions, still prevails.

No one needs to be reminded of illustrations of the effects produced on distant parts through the nervous system. During health, when all is well, it is less patent to ordinary observation, but in the disturbance of disease it is often made distressingly obvious. To refer to a previous example. Remember what often occurs in a case of continued toothache. The pain, at first limited to the diseased tooth, at length spreads to adjacent ones, then to the jaws, until the original source of the irritation can hardly be distinguished, and by-and-bye it radiates over the whole side of the face and head. The influence, again, of various states of the mind upon the bodily functions is thus transmitted. Thus, shame or anger reddens the face; thus, fear blanches the cheek and bedews the surface with perspiration.

But impressive as the evidence is of this mutual dependence of parts through the nervous system, it is nevertheless clear that this is not the sole agent of sympathy; there is another even more universal, and perhaps more subtle, if in health still more obscure in its operation—the blood.

The blood is a fluid of most complex composition. Necessarily so, for it is brought into direct relation with food and air on the one hand, and with all the different tissues of the body on the other, in the various processes of digestion, respiration, nutrition, secretion, and excretion. Therefore, it must contain all the substances which the several parts require, receiving these from food and air, and it must receive back worn-out or used-up matters. Wonderful is it, that notwithstanding its complexity and the sources of disturbance to which it is exposed by the continual introduction of raw material on the one hand and of refuse matter on the other, it can and does maintain the uniformity which is necessary to health. Circulating through the body at any given time, we may say, broadly speaking, there is blood in three stages: blood fit for present use, as it were of to-day; blood which has passed this stage, of yesterday; blood for future use, of to-morrow. So we can understand that a right state of the blood and healthy nutrition are mutually dependent. The blood must be right for nutrition to be normal; nutrition must be normal for the blood to be right.

The blood, then, is thus the medium of communication between all parts, by virtue of the incessant changes which go on everywhere between it and the tissues in nutrition. And it is not hard to understand that if any part fails to withdraw from the blood its own proper materials, or restores to the blood substances other than those which are the normal result of the changes it undergoes, the blood must be thereby in some measure, and for some time, affected; and hence, as a secondary result, the nutrition of other and perhaps remote parts, or organs, may in various degrees, through this altered blood, become modified or disturbed. It would perhaps be difficult to over-estimate the part thus played by the blood as the outcome of its great office.

Thus, then, distinct and distant organs may sympathise with each other, or the whole body may sympathise with the condition of any part. In fact, it follows that no single organ in its operation can be altogether independent of the rest; no changes can occur in it without influence elsewhere. So the growth, development, wasting, or degeneration of one will determine within limits the condition of another.

Furthermore, by this means we are enabled to explain the effect of severe local injury or disease upon the general health; for the whole body, either through the blood or nervous system, or both, will soon sympathise with the suffering of any part, and hence that form of fever which is called constitutional disturbance.

The Distinctive Features of Life.—From such a general survey let us now for a few moments attempt to distinguish the essential, fundamental, or primary features of life: those which are universally exhibited whenever life appears, from those which are accessory to these, or associated with them for special purposes in various ways.

And life, even when presented in its simplest form, may be recognised as the crowning distinction between the great kingdoms of nature; for the difference is infinitely greater between living and dead organic matter than between dead organic and inorganic substances.

And in order to appreciate this distinction, there is no need to exhibit one's ignorance in any attempt to define life, or even to discuss its nature. We are, indeed, baffled in the study of life, as we are by those subtler traits of structure with which vital phenomena are associated, yet still we may understand and appreciate its effects.

For our present purpose, then, let us consider life as a state of dynamical equilibrium: as consisting fundamentally and universally in a definite relation between destruction and renewal, in a regulated adjustment between waste and repair, whereby the condition is maintained notwithstanding constant change.

It will be observed that this is no pretence towards a definition of life. It is only an attempt to distinguish life by its essential features, when reduced to its simplest terms and divested of those elaborate details which belong to it in its more complex forms, from those changes and their effects which are more or less visible in all inanimate bodies.

Life is not a state of resistance. Very erroneous views prevail on this point. To say the least, changes are as active during life as after death. The proofs of this are conclusive and clear. We have only to remember that a living person, in ordinary circumstances, in the course of a year consumes, roughly speaking, something like 800 lbs. of solid food, about an equal weight of oxygen, and perhaps 1,500 lbs. of fluid; that, notwithstanding this vast supply, amounting in the aggregate to more than 3,000 lbs., his condition during the greater portion of his life remains the same, or nearly so, inasmuch as all this matter, after being wrought into his structure and forming a part of him, is cast off in quantity exactly equal to that taken in, but widely different in the forms which it assumes, that is, in the manner in which the several elements of it are arranged.

Change and destruction is an inevitable condition of the manifestation of life. It is involved in every act. So the power of compensating this, the repair or reproduction necessary to maintenance involves that of assimilation, which is the power of converting foreign substances into the structure of the body: in other words, the power of appropriating food.

Any adequate conception of life must include both these conditions, destruction and renewal, consumption and supply. For instance, life is not a state of change only, as opposed to stability, for this is everywhere simply a question of degree, dependent on the conditions to which bodies are exposed. Neither dead organic nor inorganic bodies are immune from change. Again, life is not peculiar as a process of repair only, for it is well known that this may occur in inorganic bodies. If, for example, portions of crystals be broken off, and if the crystals thus damaged be placed, under favourable circumstances, in appropriate solutions, they will be repaired. They will not at first uniformly increase, but the edges or angles or portions of the surface which have been chipped off will be restored, so that they will perfectly recover their original geometrical form. This, therefore, is repair or reproduction apart from life.

But in life there is the constant and concurrent operation of these two processes. Both actions are involved in the idea of life, whereby it is distinguished from mere change on the one hand, and from repair on the other. Thus, while inorganic and dead organic matters tend toward a state of statical equilibrium, during life the equilibrium is the result of compensating actions. It is dynamical.

Change, ceaseless change, then, is the necessary condition of life. The idea of temporary unchangeableness is altogether an illusion. We are never quite the same, even for a moment. That life is a flame, that it is a vapour that vanisheth away, are images no less true than trite. A living body, an organism, is a form through which vast quantities of matter are rapidly passing. The human body of an average weight—say of 140 lbs.—is a form through which at least more than a ton of material passes in a year.

Let this prime fact be thoroughly understood. All this vast amount of material does not merely come into contact with the body, and then pass off; but each particle, in its turn, enters into the composition of the body itself, replacing others that have gone before, to be itself replaced by others that are to come. The body is not merely a vessel in which matters are burnt, it is itself the very fuel which is being rapidly consumed.

Change, disintegration, destruction, is inevitably associated with the discharge of function. Every, even the slightest, action, every movement of a finger, every glance of the eye, nay, every sensation, every thought that flashes through the mind, costs structure, uses it, involves its consumption as a necessary condition.

It is a fact which is too often overlooked, that the changes which occur in any structure are always proportional to the activity of its function. The more an organ is used the more it wears, or rather wastes, away.

Some, perhaps, may be disposed to think that more modern researches have shaken the old ideas of the relation in which structure stands to function. These experiments and calculations may perhaps at first sight seem opposed to the view which has been so long and universally entertained of the relation of structure to function, that the exercise of function involves the consumption of an equivalent amount of structure; for these go to show that the work done by muscles, for instance, cannot be accounted for by the amount of their tissue which is consumed in the act; that the weight of their tissue which is transformed, as calculated by the measurements of the chief products of their decomposition, would not explain the amount of their actual energy. Still, it may be remarked in passing that in the present state of our knowledge the alternative is not inevitable, that the excess of force comes directly or simply from the transformation of food, or that certain constituents of the food, by their oxidation, yield force to the muscles, without necessarily passing through the form of muscular tissue; thus regarding a muscle "simply as a machine for getting work out of the oxidation of non-nitrogenous food."

But even if this were established, that motor force may be developed, like heat, by the metamorphosis of constituents of the food which are not converted into living tissue; that structures may transform force derived from other substances without the expenditure of an equivalent amount of their own material; still, it would not affect, from our present point of view, the relation in which structure stands to function. Still, for instance, the muscle would be the necessary material or instrument by which force is transformed or set free; still the exercise of function would involve the consumption of structure.

If it be asked why the effects of such constant and rapid consumption are not more obvious, how it is that the man or woman appears in the same person month after month, or year after year, scarcely, if at all, to our perception, changed, the answer is simply, because in life the demand and supply, waste and repair, are exquisitely adjusted. The illusion of temporary stability depends on the fact that, in health, perfect and complete renewal waits upon destruction. This is, in a word, nutrition. In life, the various structures are maintained in spite of wear and tear, and, therefore, the constant loss is not apparent. When, as after death, decay alone proceeds, the body disappears.

In certain structures, however, the very limited period of existence which is a condition of every part is obvious enough. For instance, every one knows that the outer portion of the skin, the cuticle or epidermis, is being continually shed and replaced; the hair, again, is cast off and renewed many times, and the teeth once. This is patent to casual observation. But in those structures that perish and are restored particle by particle, the change eludes direct observation. Yet it is not more true that we have a second set of teeth, or from time to time new hair, than that we have often, much oftener, formed, though in a more gradual and subtle way, new muscles, new nerves, new hearts, and new brains.

If, then, waste is in proportion to work, the rate of life of the several structures or organs must depend on the activity of their function, and so must vary very widely. Compare, for instance, in this respect, muscles and nerves on the one hand with bones and ligaments on the other. The contrast between them is shown alike in their different degrees of vascularity, or in the proportion of blood that they receive, and in the relative amount of the products of their waste. But it is not only that the rate of life of the various structures is naturally very different, but also that the rate of life of the same structure or organ varies widely in different persons and at different times, according to the conditions under which it exists. Witness, for instance, the different rate of life of the muscles of one who spends the chief portion of the day in manual labour, or some other form of active exercise, with another who passes the whole day in sedentary pursuits. No doubt, even under conditions of most absolute rest, some amount of change—some degree of waste and repair—is always going on; but this must form but a small fraction of that which is involved in energetic exercise. And what is true of muscle is also equally true of, although, for plain reasons, it may be less strikingly shown in, brain.

The fact, which is generally understood, that the efficiency of the several organs, their health and vigour, depends on their thorough exercise is founded upon sure and satisfactory evidence. But more than this: in healthy nutrition the supply is in proportion not only to ordinary demands, but within certain limits to extraordinary ones. For as in deficient exercise there is diminished consumption, and the supply is accordingly reduced, so extraordinary activity involves additional waste, and this is associated with equivalent repair. So when structures are maintained in a state of extraordinary activity, provided only that the exercise be healthy, they not merely maintain their condition, the increased consumption is not only met by an equivalent supply, but the additional demand, by stimulating vital activity, leads to a supply beyond the waste, so that the structure becomes augmented in bulk or weight, and thus more equal to the task assigned to it. Take the muscles of the arms of a blacksmith, or of the limbs generally of an acrobat, as examples of this. And with this increase of substance is often associated an improvement in the quality of a structure. Thus, such enlarged muscles are often of a more ruddy colour, and obviously firmer than others.

The pathologist is familiar with still more striking illustrations of the same fact. Let one suffice. The heart effects its purpose of circulating the blood by the contraction of the muscular walls of its several chambers, certain valves, or floodgates, being interposed to regulate the direction of the stream. Now, when these valves are damaged so as to become less efficient, the blood may either be obstructed in its progress or allowed to regurgitate. In either case a difficulty arises, which, in order that the circulation may be maintained, must be overcome. To do this, the heart is called on to make unusual efforts; it must work harder. In most cases it does so, and thus in time grows larger and heavier and stronger. This, in such a case, is not disease, but, on the contrary, is in itself a conservative change, adapted to compensate a difficulty which disease has set up: a salutary effort of nature to avert an impending catastrophe.

So deficient exercise, want of use, leads to wasting, to loss of bulk or weight, and often to corresponding impairment of quality. Look at the muscles of a limb, otherwise healthy, that from accident, in which they are not directly involved, are debarred from exercise; how they gradually, yet perceptibly, waste away, so that at length, when they are once again set free to work, they prove unequal to the slightest effort.

This law, that the state of health and vigour of a structure is determined by the conditions under which it lives, holds good with all our organs. Just as manual labour or repose affects our muscles, and even, though in a less degree, our bones, so is the condition of the brain improved by mental work and impoverished by idleness. Thus, the brain of the sluggard will inevitably degenerate, while no one can be aware of what he can accomplish until by a system of active and sustained exercise he has raised his mental powers to their highest degree of efficiency.

Herein consists the chief advantage of education over and above the actual knowledge which is thereby acquired. It is the means by which the mental faculties are not only trained and disciplined, but evoked and cultivated. Its end is not merely the attainment of so much knowledge, but rather the development of mind force.

Not only do the several organs vary widely in degree of vital activity, but the rate of life of the body as a whole is very different at different periods. All are familiar with the contrast in this respect between youth and old age. All vital changes are most active during the earliest years, and they diminish in rapidity as age advances. During childhood there are growth and development; then during what is called the prime of life, for the most part, simple maintenance; at length, in the decline, wasting and degeneration. Observe the difference between growth and development and between wasting and degeneration. Growth and wasting, which are opposite conditions, refer to quantity only. In growth there is simple increase of bulk or weight; in wasting there is simple loss of it. Development and degeneration, which are also opposite conditions, refer to quality. In development there is improvement in the structure of a part; in degeneration the reverse. Growth and development may be, and often are, concurrent, as in the progress of an individual or organ from infancy, or its first formation, to the adult condition, or its state of higher perfection; but they are by no means necessarily so. Organs may simply increase in bulk and weight, in quantity, without yielding any evidence of corresponding improvement of quality, as, for example, bones and muscles. Or development may proceed without concurrent growth; nay, with even diminution of weight and bulk. Thus, in the instance of a structure, in certain stages of development of muscle, while the fibre is obviously improving in quality, rapidly assuming characters which belong to the mature condition, it as rapidly suffers loss of bulk, so that a well-formed fibre will measure much less than one far behind it in development; or, for a remarkable instance of the whole individual, tadpoles in developing into frogs lose two-thirds of their weight.

So with wasting and degeneration. They may be, and often are, as in the decline of life, concurrent; but by no means necessarily so. Either one may proceed without the other. The causes that determine which of these changes shall occur are at present somewhat obscure, but the common cause of either or both together, when premature, is want of due and proper exercise.

But during life there is a power beyond all forms of ordinary nutrition, whether it be presented as simple maintenance or as growth and development: a power beyond all this, whereby unusual demands may be supplied, extraordinary losses may be met—the power of repair. We are wont to dwell on the wonderful adaptation of means to ends everywhere visible in our structures and functions. We are lost in admiration at the marvellous manner in which the wear and tear of our organs is met by immediate renewal. What must we, then, think of this process of repair? It is not enough that the usual demands of the system should be fully provided for; that natural, daily, hourly, constant losses should be sustained and compensated: there is, as it were, in anticipation of mischief, of injury or disease, by whatsoever cause produced, a power in reserve, by which the loss may be restored or the damage repaired. This power, with which all living beings are fore-armed, varies widely in its degree in different cases.

There is a vast and signal difference in the effect of injuries upon the lower, or simpler, and the higher, or more complex, animals. Thus, the simplest forms of life will survive mutilation to any extent; nay, each fragment, possessing in itself the conditions of life, will presently become a new creature. Thus, a natural process may be rudely imitated by the artificial division of polyps and worms. But as the scale of life is ascended, as the principle of division of labour is carried out, and the several functions and structures become separated and limited, the power of reproduction is gradually reduced; it is confined to legs or tails, or other appendages, as in tritons and lizards; until at last in man it becomes in comparison very insignificant. With few and slight exceptions, the reproduction of lost parts is no longer witnessed; for the most part there is only more or less imperfect repair.

This remarkable difference in the repair of injury is observed not only between different animals, but also in the same animal in the course of its development, and for really the same reason. The capability of reproducing lost parts, whether in the case of the whole animal or of any particular structure, appears to exist in an inverse ratio to the extent and nature of the changes through which it has previously passed. So, as a rule, the degree and rate of reproduction varies indirectly as the age; sometimes it is only in the very young that any reproduction occurs. Every one knows that children recover from and repair injuries much more rapidly and completely than adults. Children will go through so much because they have gone through so little. The old, for the most part, can bear but little in addition to what they have already gone through. Surgeons, guided by this, do not hesitate to adopt plans of treatment in children which they would not venture to practise on those advanced in life.

This gradual decline of a power in reserve is more commonly, though less strikingly, shown in another way. One of the most constant effects of advancing age is the diminishing ability of sustaining extra exertion, or of making any unusual effort. In middle life there is a steady loss of elasticity. The structures, by custom, become adapted to certain regular movements, but resent any attempt at excess. The daily work of ordinary life is done as heretofore, without any consciousness of declining energy; but if tempted to join in some youthful pastime, we are apt to be painfully reminded that we are no longer young. Those who are not wise enough to recognise this change often pay dearly for evidence of it.

We may pursue this interesting subject a little farther, and observe that the several structures of the human body also differ widely in their power of repair after injury. Bones and tendons, for example, after being broken or divided, will unite so perfectly that some time afterward no trace of the injury can be discovered, the restoration is complete; while other structures, such as muscles, are never thoroughly restored, but are joined again by another substance, which remains throughout life as a scar, always as evidence of the repair of, but incomplete recovery from, the injury. And when the matter is still further investigated, it appears that there is a distinct relation between the character of the structure, the mode of its original formation, and the power it possesses of reproducing lost or injured parts. The simplest structures, such as tendons and bones, which are made up substantially of fine delicate fibres, impregnated, in the case of bone, with earthy salts, and which are originally formed out of a structureless material, through a series of comparatively simple and direct changes, exhibit this power of reproduction in the highest degree. More complex structures, evolved through more complex processes, have an inferior power of renewal, until in the most elaborate structures, with the most complex mode of original development, the power of recovery from injury is reduced to the lowest degree, and takes the form only of comparatively imperfect repair. Thus, as in different members of the animal kingdom, so in various structures of the same animal there exists a direct relation between simplicity of construction, or of original development, and the power of recovery from mutilation, or of reproducing lost parts.

It is interesting to observe that, in the absence of perfect restoration, the substance, which in the instance of repair forms the scar, is composed of simple fibrous tissue, very like the structure of tendon or ligament. These scars, which may be very easily studied in the skin, where they are common and obvious, undergo, subsequent to their formation, important changes. The new substance becomes consolidated; it grows firmer and denser, and gradually contracts. By this shrinking it becomes very much reduced in size, and the structures to which it is attached are drawn in. Thus, when a scar is examined many months after a wound has healed it is found to occupy only a fraction of its original extent; and if at first extensive, the adjacent skin is displaced, and for some distance is made tense by being stretched. In extreme instances, where the previous loss of substance has been great, as after severe burns, the persistent and powerful contraction of the large scars often in this way produces dreadful deformity, and by limiting their movement, very seriously interferes with the use of the limbs.

But although in this way scars tend for a very long period gradually to grow smaller, yet from another cause they are subject to increase. A scar on a small child grows with the growth of the whole body, so that in the course of years it may extend considerably: in fact, it has become a part of the body, and subject to the laws which regulate the growth of the natural structures.

Thus, then, different degrees of life belong to different periods of it. The seven ages of man—infancy, childhood, youth, adolescence, manhood, decline, senility—may for physiological purposes be reduced to three—growth and development, maturity, decline. These are distinguished by the relative degree of the constructive and destructive processes. In the first, constructive changes are in excess; in the second, constructive and destructive changes are balanced; in the third, destructive changes are in excess. But they are distinguished also, and in this more, by the relative rate at which these changes simultaneously proceed. In early life the vital processes are most rapid, and they gradually slacken as age advances.

Once more. During the course of life different organs and systems of organs attain their most perfect condition at different periods. An illustration of this, in a general way, is presented by what are called the vegetative and animal functions. The former are in full and complete operation long before the latter. Another appears in the case of certain glands, which attain to maturity one after another. But a more familiar instance is seen in the organs of the senses and of the intellect. It is very well understood that the senses are possessed in all their acuteness before the intellectual faculties are fully developed, and the senses fail before the intellectual powers decline.

Furthermore, there can be little doubt that the rate of life or of tissue-change varies in different persons, and the extent of this variation is characteristic of human nature. Animals are less eccentric than man. In their physiology, instances of individual excess or defect do not so commonly appear as in him. In them, too, each organ is more accustomed to go constantly in harmony with the rest. The whole are active or the whole are indolent. Man, although, of course, his various organs hold the same physiological relation to each other, differs in this respect in a singular degree. Various temperaments, individual idiosyncracies, characters distinguished from others, are far more marked among men. Allowing fully for imperfect observation, we are less alike than are animals. And what is true of different men is true, in a less degree, of different organs of the same man. Activity of body and of mind are in him, by no means, in such constant accord as in animals. The impression is general that, as a rule, the size of the brain and the mental power of an individual are in proportion: that a man with a large brain has more mental capacity than another with a small one. Why this rule is so frequently broken, is subject to such numerous exceptions as to render any inference of intellectual power drawn from the size of the head or brain a very uncertain one, is not, perhaps, so difficult to explain if the question of rate of life or of tissue-change be taken into account. The vital activity of the organ, or its rate of change, is a factor that cannot be so readily or accurately reached, but, nevertheless, this which is involved in the nature of the constitution, or temperament, or idiosyncracy, has to be considered. Is the whole man, or his brain, quick or slow, lethargic or energetic?

How strikingly is this illustrated by the influence of age! How marked are the different degrees of cerebral activity at different periods of life! How quick the apprehension, how vivid the imagination, of the young! How prone the perceptive faculties are to grow dull as life advances! Of course there are other changes, for the most part of greater importance, which more than compensate these, and other influences which come into play. But, so far as simple rapidity of function is concerned—mental activity—the contrast between the young and old is obvious. Even a very few years are apt to produce a considerable difference in this respect. Those who have had much experience in the conduct of examinations, especially of competitive examinations, are probably aware of this. The older men, notwithstanding many advantages on their side, such as a longer period of training, a larger amount of work, perhaps a wider range or greater depth of study, do not, as a rule, come out higher than the younger ones. Of course, one cannot pretend to be precise in such a statement as this; there are circumstances outside the present question to be taken into consideration. But the objection often urged, that it is unfair to allow older men to contend with younger ones in competitive examinations on the score of their superior advantages, is met by the fact that the younger men, at least, can hold their own in the struggle, and this chiefly because of the quickness of their work. They can think better against time.

Although to many the illustration is not so familiar, it is oftentimes still more striking in cases of illness. In convalescence after fever or other grave disease, in which the powers of the system have been taxed to the uttermost, the exhaustion of the higher nerve-centres is often shown in various ways; but, perhaps, in none is it more remarkable than in the sluggish flow of ideas through the mind. Questions are clearly, but slowly, understood, and at length intelligently answered; as well answered, perhaps, as they could be in perfect health, but then, so much more time is taken up by the effort. The conversation must be carried on deliberately. Even ordinary rapidity of utterance on your part will cause distress, and you must wait patiently, sometimes even for a long while, before the answer comes. But as the blood and its circulation is restored, the stream of thought quickens, until it flows again as brightly as ever.

We are, indeed, but too familiar with another illustration of the same fact in the vast difference which may be so frequently observed in the mental activity, or rate of work, of the same brain. How widely various is the productiveness of the same organ at different periods! Think, for a moment only, of the effect of quickening the cerebral circulation, or increasing its supply of blood, by the use of a stimulant. Under this spur, with what a spring will a languid and exhausted brain start forward into rapid and energetic action! Much is revealed by the influence of a glass of wine upon the flow of ideas.

But beyond this, there is a consideration of far more importance. In man, the state of the brain in this respect varies, it may be repeated, in a singular degree. Its rate of change can hardly be judged of by that of the body generally. Other organs may be active, and this idle, or this may be full of life, while the rest are indolent. Necessity, will, habit, external influences, accidental associations, and a host of circumstances, come in here. Hence the important part played by the constitution, or temperament, or energy, or activity, in the duration of life; whether the fire consumes slowly or burns intensely. Thus, some who have had the fullest opportunity of forming a sound judgment on the matter have been disposed to believe that, as a rule, there is a direct relation between the habitual slowness of the pulse and the duration of life; and although more numerous and exact observations on the subject are wanting, the view is, to say the least, a very reasonable one. But it is not a question of the consumption of every part. The duration of life is rather to be measured by the rate of life of the most active of the vital organs. Just as the strength of a fortress is only the strength of its weakest part, so it may be said that the term of life of an individual is only the period of duration of that vital organ which is worn out soonest. And thus we can appreciate not only the point, but the weakness of the comment attributed to Swift on hearing some one speak of a fine old man: "Nonsense! If his head or his heart had been worth anything, they would have worn him out long ago!"

Most people, no doubt, have some amount of brain substance in reserve: that is, they never get the best they can out of what brain they have. For one instance in which the brain is overworked there must be many hundreds or thousands of cases in which it is not used enough, even for the ordinary conditions of health. Yet the laws of nature are inexorable, and in this case the penalty paid is heavy for any attempted violation of them. For the brain, as for every organ, exercise, a due amount of it, at least, is a condition of health. Waste or disease is the consequence of extreme idleness. For other vital organs nature insists on due and proper work. We cannot, if we will, make the heart, or lungs, or spinal cord altogether idle. Their regular work is determined beyond our rule, as a condition on which life itself immediately hangs. The higher part of the brain—the cerebrum—is more within our control. But to what degree? Not so far, probably, as is often imagined. Can we make it altogether idle in the physiological sense? Can we completely rest it, except in sleep, even if we try? Is not its activity also, within wide limits, an imperative condition? After all, we can only determine, for the most part, in what way it shall be active. If not used worthily, it must be employed unworthily. It is an old remark, that persons who have nothing to do are often the most busy: that is, when the brain is not occupied on important subjects it employs itself on trifles. In animals of the same species, it is probable that the quality of the brain-work does not vary widely; but among men brain-work differs far more in quality than in quantity. Most men, for some portion of the twenty-four hours, are "up and doing." But doing what? The grades of cerebral activity are infinite. In this organ, it does not appear to be so much a question of rest and exercise as to what purpose the activity which is imperative shall be turned. Dr. Watts, from another point of view, long ago, made this idea famous.

Then there is the all-important question of culture, the increase of power by constant healthy exercise, which has been already alluded to, increase of size, to some extent, but still more, no doubt, increased facility of change. So that it comes to pass that in the end mere mass has not much to do with the result. It is superseded by motion; and the fact is too familiar that the work of a large or heavy brain out of condition is nowhere in the race against the energy of one much less that has been diligently cultivated. So far as simple activity of intellect is concerned, the influence of practice or exercise is often strikingly shown in the contrast of the mental state of individuals in cities and in rural districts. Widely different is the usual rate of thought in the two cases. Every one can recall conversations with uneducated persons in various places which illustrate this. It may be said, indeed, "All other circumstances being alike, the size of the brain appears to bear a general relation to the mental power of the individual." But when are all other circumstances alike?

As the amount of work done cannot be reckoned from mere bulk of body, so life cannot be estimated by mere number of years. It must be known also how much of life there has been in each year. Neither could it be told simply from the size how much work a brain has done, or can do. It would be necessary to know how long it can work, and how much it can do in a given period. It is always a question of rate into time.

Sleep.—Action involves destruction. The discharge of function implies the consumption of structure. Rest is necessary to repair. Therefore, alternate periods of activity and repose are common to all living structures. For it is evident, in order that the condition of an organ may be maintained, this waste must be repaired, and the repair must be equal to the waste, the supply to the demand.

The certain fact that active exercise is destructive of substance does not preclude the possibility that, even during its continuance, repair may be to some extent proceeding simultaneously with the waste, but it does involve the proposition that during active exercise the amount of waste exceeds that of repair. Therefore, in order that the waste may be repaired, that the condition may be maintained, there must be periods of comparative inactivity, of more or less complete repose.

If active exercise could be continued without intermission, it would at length wear out the structure, and the limit to its duration is, no doubt, associated with the amount of tissue consumed. Thus, the sense of fatigue in muscles may be due to the want of balance between waste and repair. Exercise, therefore, is followed by repose —the period of renewal; and when this is accomplished, the body is once again in a condition for active exertion, which must at length, in turn, be succeeded by repose. Thus, then, there must be, as the condition of vital action, alternate periods of exercise and repose. The intervals vary widely in different cases, but both states are natural to all structures, and necessary to their health.

Hence, the need of sleep—that is, a season of rest—arises from the excess of the waste of certain nerve-centres over their repair during the hours we are awake. But complete and prolonged repose, or abeyance of function, of some nerve-centres is incompatible with life. The spinal cord and medulla oblongata, for instance, like the heart and some other parts, must be restored through intermittent periods of comparative repose. It has been forcibly said that the true spinal system never sleeps. There is not, however, this immediate necessity for the sustained activity of other portions of the nervous system, and so these yield to rest more profound and prolonged.

Sleep is especially rest of the brain—of the sensorium and cerebral lobes. Its leading phenomena are the result of the more or less complete suspension of their functions; for sleep is the suspension of consciousness and of the mental faculties generally. Sleep is to the brain what repose is to every other organ of the body. While, therefore, all living beings, all organs and structures, rest at intervals, those animals only which possess a brain, and are endowed with consciousness, can be properly said to sleep.

The sleep of plants is often spoken of. But it cannot be correct to say that plants sleep, if sleep be understood in the sense in which it is generally, and here, employed, to imply a state of unconsciousness, and of suspension of other faculties which depend on the activity of the highest nerve-centres. Taken thus, in its common and proper sense, neither plants nor the lowest animals sleep, because they are not endowed with the organs whose state of rest is sleep. But plants and all living beings exhibit periods of repose or comparative inactivity.

A great deal has been said about the circulation of the brain during sleep, and very opposite opinions have been expressed. In this, as in perhaps many other cases, analogy is too often overlooked. There is no reason to suppose the brain to be an exception to what appears to be an universal law; that the circulation in an organ varies with its activity. That during the repose of the brain its circulation is correspondingly reduced is the conclusion to be drawn from the effects of rest on other structures, and this conclusion is supported by direct evidence.

And it must be understood that the diminished supply of blood to the brain during sleep is the consequence, and not the cause of, the state. The supply of blood to an organ depends on its wants, not its wants on the supply. Increase the activity of an organ, and its circulation is increased; diminish its activity, and its circulation is diminished. The supply is regulated by the demand.

Sleep, of course, like all other forms of rest, varies widely in degree. It may be so light as to mean no more than a passing reduction of activity, mere drowsiness; it may be so profound as to consist in a complete suspension of all those functions which depend on the nerve-centres within the skull.

Dreaming and Somnambulism.—Much light appears to be thrown on the physiology of the higher nerve-centres by the study of the curiously interesting conditions of dreaming and somnambulism.

When sleep is partial or imperfect, the functions of those ganglia whose rest is sleep will not be entirely suspended. They will remain more or less active. Impressions will still be recognised by the hemispheres, and will give rise to ideas. Thus, dreams are produced. Dreams, therefore, are the result of imperfect exercise of the hemispheres when in a state of partial repose. There may be total absence of consciousness of external things, and yet withal a state of mental activity, varying greatly in degree and duration. It may be so slight and transient that nothing more than shadowy and evanescent images float from time to time across the mind, leaving no trace upon the memory. It may be so energetic that impressions produce the most vivid, definite, and enduring pictures. It is not at all uncommon, indeed, for impressions in these circumstances to produce ideas more freely and powerfully than in the waking state, inasmuch as they are not interrupted by the intrusion of external circumstances, whose influence is at the time shut off. Dreams, then, occur when sleep is not profound. They cannot arise during complete repose. There is no sufficient reason to deny the existence of a period of complete unconsciousness, of complete suspension of the mental faculties. Doubtless the brain, like other organs, is at times in absolute repose. While dreaming, sleep must be considered imperfect.

Again, if the general view here expressed be the correct one—that dreaming is the natural condition of imperfect repose—there is no good reason for denying the supervention of dreams at any period of sleep. It has been a favourite doctrine with some, with one illustrious man especially, that dreams occur only during the period of waking, that they are peculiar to the period of transition from sleep. But it seems to be more consistent with knowledge and observation, as, for instance, with changes of expression in sleep, to believe that they are not necessarily confined to the waking state, but rather that they may arise at any moment when sleep is not profound.

In a healthy state, and in natural circumstances, however, sleep will be profound or prolonged according to the degree in which the brain has been fatigued by previous exertion. But as the brain becomes refreshed the want of rest is reduced, and sleep gradually becomes lighter. Hence it is that towards the termination of our slumbers we are apt to dream most vividly and coherently. Hence the adage that morning dreams are true.

There can be little doubt that dreams are very transient, but the evidence of the extreme rapidity which has been assigned to all of them is defective. The idea that they are almost instantaneous is connected with the one just alluded to, that they are limited to the waking state. Of course, the duration of dreams bears no comparison to that of the events and circumstances which they picture, but looking at the relation of dreaming to somnambulism, their frequent concurrence, the period occupied by day-dreams, and the time that disturbed sleep and other indications of dreaming will sometimes last, it is perhaps more reasonable to conclude that some dreams are not so instantaneous, as many imagine.

It is highly probable that all animals with cerebral hemispheres dream. This conclusion, which naturally follows on the view here taken of the nature of dreams, is confirmed by observation. For example, dogs will growl, snarl, and snap, whine, and wag their tails, or prick up their ears in sleep, and start up suddenly in alarm, as if in danger, without any external cause. Lucretius (De Rerum Naturâ, Liber IV.) describes minutely the indications of dreaming in the lower animals.

When impressions reach the cerebral hemispheres, they arouse ideas. Impressions may be objective—arising from without, what we call real; or subjective—arising from within, what we call fancies. The exciting cause of dreams, then, may come from without, and this would imply some degree of activity of the sensorium; or from within, for it is only during complete sleep that the cerebral lobes are quite inactive. As during the waking state we cannot obliterate ideas, although in darkness and silence all external sources of impression may be removed, so when sleep is not profound, and the cerebral lobes are in some degree active, dreams more or less vivid must occur.

As the chief feature of sleep is a state of unconsciousness, so the remarkable feature of dreaming appears to be an absence of the power of the will over the current of thought and over action. Thus, ideas are aroused in rapid succession without guidance or correction, and no volitional acts are accomplished. Hence the frequent incoherence and inconsistency of dreams. Of course, there are all degrees of this. Dreams may be, and often are, consistent and rational, whether from the more complete exercise of the cerebral lobes, or from the nature of the impressions which excite them; but oftentimes they are characterised by a strange want of regulation and co-ordination of the ideas which represent them. And of what slovenly patchwork are our dreams sometimes made up! A fragment of our waking thoughts here, another there, fantastically put together into an utterly unreasonable, yet in some sense an intelligible whole. When such a dream is remembered, it is curiously interesting to trace back, as we often may, various portions of it to their respective sources, to recall the actual scenes or mental visions whence they have been derived.

When, therefore, we dream what we call nonsense, it is because there is a partial or complete absence of voluntary control over the current of thought, and because we cannot compare our conceptions and ideas with surrounding objects and circumstances, and thus correct them.

The extent to which the ideas that constitute dreams are coherent probably depends, in great measure, on whether they are habitual or strange to the waking state. When the will is not alert, old ideas are more apt to be orderly than new ones, for the former may fall into their accustomed sequence, whereas the latter have not even habit to arrange them. Every one knows how an idea excited by an impression may forthwith arouse a train of others which have been before associated with it; how, in this way, by some object that catches the eye, or by some sound that strikes the ear, we are carried back to past scenes which have long since been forgotten. In such a case, we know also that a distinct effort of the will is often needed to recall the truant mind to present affairs. Thus, for the most part, dreams are coherent and rational in proportion as they arise out of existing circumstances. The wildest and most absurd ideas result from some temporary disturbance of some function, or from some local or general discomfort. And it is instructive to remark that when, in dreams, probabilities are violated or possibilities disregarded, the ideas are usually of such a nature that we can, when awake, correct them by the influence of surrounding circumstances, such as those of time and space.

In comparing, then, the condition of the mind in dreaming with its active state while awake, we are led to notice these distinguishing features:—The will is in abeyance; it ceases to control, or rather to direct, the current of thought; the correcting influence of external impressions is suspended.

Impressions conveyed to the brain, when awake, excite ideas which are for the most part, in a healthy mind, subjected to the regulating influence of the will; and if they give rise to acts, these are voluntary and rational. But when the influence of the will is suspended, and it ceases to direct the current of thought, the acts which such ideas thus produced may at once excite are often strikingly irrational or altogether absurd. Such examples may be seen in persons intoxicated by alcohol, chloroform, ether, or laughing-gas. This condition is hit in the drunken Cassio, when he is represented stumbling on to his knees, and then, the attitude suggesting the idea, beginning to pray. So, again, we often observe sight, sound, or touch starting a current of ideas in one under the influence of ether or chloroform. And it is interesting to note that these impressions do not, for the most part, evolve correct ideas of the real circumstances of the case, because they are unusual ones, but they are interpreted according to the habitual circumstances in which they are experienced. *In vino veritas.*

As in these cases, so and in the same way it is doubtless possible sometimes to lead the ideas during sleep, when not profound, by means of external impressions, and even to determine their nature. Thus, gloomy ideas may be suggested by a dull tone of the voice, while cheerful ones may be aroused by lively sounds. In the same way also, the ideas may be adapted to the circumstances in which a person may be placed. Every work on the subject contains some illustrations of this.

And, just as a dream may be started by an external impression, so an impression made on any of the senses during a dream will oftentimes fall into the current of ideas then flowing through the mind. Thus, a noise may become the report of fire-arms, or the shout of a multitude, or a peal of bells, or something else, according to the subject of the dream.

The nature of dreams in their relation to the absence of the correcting influence of impressions from without is well illustrated by the effect of darkness and silence on delirium. The phantoms which then arise will often at once disappear in the presence of light or at the sound of a well-known voice. And here it may be observed that, in proportion as the mind is uncultivated and barren, with but scanty stores from the past to feed on, or undisciplined, the will being feeble and powerless to direct the thoughts or to regulate the ideas, so it is dependent on a constant supply of external impressions and on surrounding objects. The opportunity for reverie and abstraction which the poet and philosopher anxiously solicit and joyfully embrace, the ignorant and idle dread and shun. Hence the disastrous effects of solitary imprisonment appear to be in proportion to the want of mental culture in the victim.

There is a peculiar condition of the mind, often occurring in some persons, which is well expressed by the phrase day-dreaming. In this state the ideas are allowed to flow on without control. They are not restrained by any effort of the will; in the worst form they are not even co-ordinated. One idea suggests another, and so on, until the thoughts have wandered far away from the original subject. Nothing is seen but the visions of fancy. The most improbable, nay, impossible, prospects are conjured up, and contemplated either as present or future realities, and no attempt is made to check or control the most extravagant or erroneous conclusions. Here, however, at least, at the outset, there is an indisposition rather than an inability to reason. When in this state, a person is said to build castles in the air. The mind is wholly withdrawn from the consideration of external and surrounding circumstances, and revels in the luxuriance of its thoughts. This is really a dreaming state, although, owing to the activity of the sensorium, day-dreams are more readily corrected by external circumstances.

What are called imaginative minds are most subject to this condition, which must be regarded as an unhealthy one, for if not resisted, but allowed to increase, it may weaken the intellectual, the reasoning powers, and otherwise impair the mind. "All power of fancy over reason," says Johnson, in his characteristic way, "is a degree of insanity. By degrees the reign of fancy is confirmed. She grows first imperious, and in time despotic. Then fictions begin to operate as realities, false opinions fasten upon the mind, and life passes in dreams of rapture or of anguish."

The imagination and the reason are in great measure antagonistic faculties. Perhaps they are never found highly developed together. It is only when the imagination is stronger than the reason that it can escape from its control. When the latter predominates, the former is held in check. No author has set this forth more clearly and vigorously than Lord Macaulay, who has handled the subject in more than one of his essays. In that on Dryden especially, he says the imagination is never so strong as in people incapable of reasoning. With striking force and felicity of illustration, he shows how, in the development of the reason at the expense of the imagination, "the progress of a nation from barbarism to civilisation produces a change similar to that which takes place during the progress of an individual from infancy to mature age." "Our judgment ripens, our imagination decays." "Such is the law of our nature." He points out also the analogy in the triumph of the imagination over the reason between savages, children, madmen, and dreamers.

Some persons are almost always dreaming, even when awake, and this constant day-dreaming seems to be, at all events, incompatible with a well-disciplined mind and a strong will. Coleridge may be mentioned as a conspicuous example.

Indeed, if we attend at all to the state of our mind, we must observe that it varies widely; and during a considerable portion of our waking hours, in many persons, especially in the young, its condition is not far removed from that of day-dreaming. When we are not at work, when the attention is not fixed, during periods of leisure, the intellect is wont to escape insensibly from the dominion of the will, and to wander far on into the regions of thought, one idea suggesting another, which forthwith takes its place. One step farther, and the influence of surrounding circumstances is almost shut out, and the imagination revels without restraint. Then we may be said to dream.

Day-dreaming, or reverie, and the dreams of sleep are connected by a peculiar phase of dreaming, which sometimes occurs when the sleep is unusually light, or more often when we are awakening out of sleep. In this state the sensorium is more or less active; we are conscious. It is characterised, moreover, by a partial and imperfect control over the current of thought, and a voluntary effort, in some degree successful, is made to prolong agreeable ideas and to dispel gloomy ones. This condition, oftentimes very pleasant, must be familiar to every one, as occurring at the dawn of day, before rising.

Again, every one knows that a dream out of which we have awakened is very liable to recur if we soon fall asleep again. We dread this recurrence when a dream has been horrible, or court it when a delightful vision has been interrupted. Such cases tend to establish the relation between our sleeping and waking thoughts. By watching and analysing the phenomena, we can observe how insensibly they pass into each other, the vision of our sleep rising into ascendancy as the influence of external impressions and of the will is withdrawn.

The supremacy of the will, in its relation to the intellectual powers, * is the best

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* We say the will in its relation to the intellectual powers, for distinct and widely different acts are commonly included in the operation of the will. The will is referred to in relation to certain forms of muscular action. We speak of voluntary or volitional acts, meaning that these are determined by the will. Again, we speak of the will as governing, in a greater or less degree, the operations of the intellect, as directing thoughts, regulating the ideas, controlling the imagination, and so forth.

Surely a distinction ought to be drawn between the power of the will in determining certain actions of the body and the influence of the will in its relation to the faculties of the mind. Is the power by which certain movements are determined identical with that by which the various indication of a healthy mind, and failure of the power of the will is the earliest and most obvious symptom of mental defect or debility. As by the presidency of the will man is distinguished from animals; so do men differ widely in the degree to which the power of the will is developed. In any case, it may be said that when the will is strongest, when its influence over the intellectual faculties, as well as over the passions and emotions, is greatest, the mind is in its most efficient state. Now, the remarkable analogy between the mental phenomena in dreaming and insanity has not been overlooked. As in dreaming, so in insanity; the power which the mind in a healthy state possesses of directing and controlling, within certain limits, the current of its thoughts is to a greater or less degree lost. And the ideas and imagination which thus run riot, as it were, are not corrected or checked by the influence of external things through the senses. There is, however, this difference: in dreaming, the senses are more or less closed; in insanity, these paths to the mind are still open, but the disordered intellect ignores the evidence which they convey.

In reverie, the same condition to a great extent prevails. It is most common and intense in minds in which the emotions and imagination predominate. In the state called abstraction there is, however, this difference; that whereas in either condition the influence of external impressions is for the time ignored, in reverie the will is in abeyance, in abstraction it is dominant; the will has, as it were, the intellectual powers well in hand. A train of thought is guided without interruption to a logical conclusion, and therefore this condition is eminently favourable to sound and sustained reasoning.

The sense of fatigue that follows upon great mental exertion seems to be in proportion to the effort of the will which has been necessary to accomplish the task. As with manual, so with mental labours: those which are executed with the least effort involve the least fatigue. Volitional acts, whether of body or mind, which involve intense effort of the will, produce, beyond all others, exhaustion. Thus, most men who are accustomed to task severely and exhaust their mental powers have

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intellectual faculties are guided or governed? It has been said, "We have in our own consciousness of effort, and in our experience of subsequent fatigue, a very strong indication that the power which thus controls and directs the current of thought is of the same *kind* with that which calls forth volitional movements of the body, though exerted in a different mode." But is the indication thus afforded strong enough to meet the evidence which tends to establish a distinction? There appears to be no correspondence between the power of the will in its relation to the body and to the mind. Man is pre-eminently distinguished from all animals by the power of his will over the operations of his intellect; whereas in the power of the will over the muscles, in various voluntary acts, he is inferior to many. Just as in children, savages, madmen, and dreamers, so in the lower animals; there seems to be great deficiency, or almost total absence, of the power of the will, not over muscular movement, but over the current of thought. When animals are said to be deficient in will, this is true in relation to the mind only. To deny them the possession of a strong and vigorous will in relation to muscular action is to put forth a mere dogma in opposition to the most obvious and familiar facts. How can it be reasonably asserted that animals are incapable of intensely volitional acts?

So, among different men, and even in the same man at different periods of his life and in different circumstances, there is no direct relation between the power of the will in its influence on the body and on the mind; indeed, oftentimes rather an inverse one.

At all events, the word will, as currently understood, includes the power by which certain acts are determined, and the faculty by which the various operations of the intellect are co-ordinated and governed.

experienced at times a temporary failure of the will to control and direct the current of thought. For a few moments there is an utter inability to concentrate the attention on a particular subject. There is, as it were, a mental struggle before the purpose is accomplished. This is a strong hint to rest awhile.

All forms and degrees of mental activity exist, from intense voluntary thought, or the clearest and profoundest reasoning, to the wildest insanity or the most incoherent dreams.

Now, just as the dreams may be regarded as due to partial activity of the cerebral lobes when in a state of imperfect repose, so may the condition termed somnambulism be regarded as essentially the result of a state of more or less complete activity of the sensorium, the hemispheres beyond being nevertheless at rest. In what may be called the purest form of somnambulism, various acts may be accomplished in the most perfect manner as the direct result of impressions, without any evidence of the intervention of ideas.

But, although in somnambulism impressions do not necessarily arouse ideas, yet they nevertheless produce sensations and determine sensori-motor acts. That they reach the sensorium, and are not merely excito-motor in their nature, is evident from their results. Sounds are sometimes heard and objects recognised by the sight and touch.

The term somnambulism appears to be very loosely employed. In its most common acceptation, a combination of dreaming and somnambulism is implied. Perhaps, indeed, this is the most common form of somnambulism. Not only is the sensorium active, but the hemispheres themselves are partially awake. A common instance of this is "talking in sleep." What is called nightmare is an ugly form of this combination, and it is instructive to notice that this usually depends on some eccentric and morbid irritation, as indigestion. But it is also sometimes due to imperfect arterialisation of the blood, and such defective action of the lungs or heart is a common cause of the wildest and most frightful dreams, of what may be truly called delirium in sleep. Although the description usually given of somnambulism would imply an active state of the cerebral hemispheres as well as of the sensorium, would include a state which is essentially that of dreaming—so that somnambulism has been described as an "acted dream"—yet, while it may be admitted that this more complicated condition may be a common one, it is important to recognise the fact that a state may occur in which some or all of the sensorial centres are active, the cerebrum itself being nevertheless in a state of complete repose, the actions which result being simply sensori-motor, or instinctive ones. Thus, no ideas are aroused and nothing is remembered. This may be described as the simplest and purest form of somnambulism.

It seems, then, that the clearest and most correct idea will be obtained of these two states, and of their relation to each other, by regarding them as manifestations of various degrees of activity of those centres which in profound sleep pass into a state of complete repose; that either alone may be active while the other is at rest; or both together, in imperfect sleep, may exhibit all degrees of partial activity in various proportion, short of that thorough and complete exercise of their functions when wide awake.

It appears that this view will afford an insight into certain facts which do not otherwise admit of explanation. For example, dreaming is more frequent than somnambulism, because, of all portions of the nervous system, the cerebral lobes are the most sensitive to variations in the quantity and quality of blood circulating through them. Witness the effects of alcohol, ether, and chloroform. Again, somnambulism is more common in the young, because then the sensorial centres are more prone to activity. With regard to dreams, the rule is less general, being influenced by habits of mental exercise. Again, the remembrance of dreams, not of somnambulistic acts: it is important to note the absence of memory in somnambulism. It would appear that acts purely somnambulistic are never remembered or recalled. This seems to point to their nature. They find their parallel in instinctive actions. Once more, the dexterity and accuracy of somnambulistic acts; for example, of muscular movements in walking. Perhaps, in this case the cerebellum is awake also. The somnambulist walks across a narrow plank over a frightful chasm steadily, and without fear. Why? Because the act is a sensori-motor one, and no idea is called into play. For the same reason, a person wide awake may accomplish the same feat in the same manner, if the danger be concealed from him, if he have no idea of it. In the former case, he may see it, but has no idea of it; in the latter, he has no idea of it, because he cannot see it.

In this view of the matter, therefore, the actions of the somnambulist are essentially of the nature of instinctive ones. A careful analysis of them will show that they possess this character. In the simplest and purest form of somnambulism, as in the simplest and purest examples of instinctive acts, there is not any satisfactory evidence of the operation of the intellectual powers. In either case is seen the adaptation of means to ends, but there is no evidence of the intervention of ideas, of the calculation of consequences, of reason. This difference, however, must be noted in the two cases. The operations of instinct are invariably associated with an active and acute state of the senses. In somnambulism, all the senses are not commonly in full activity. Cuvier perceived and pointed out this relation.

Summarily, then, these several states may be thus contrasted:—

In profound sleep, there are no acts beyond excito-motor ones, and even these are reduced.

In somnambulism there are, beyond these, sensori-motor acts.

In dreaming, ideas are aroused. Impressions are either subjective or objective. If the latter, it is presumed that the sensorium must be in a state of at least partial activity.

Rhythmical Action.—Certain muscles of the body work in a remarkably regular manner: the heart is the most striking instance, and this action is said to be rhythmical. It consists, as we have seen, in a series of alternate contractions and dilatations of its several chambers, which are produced by equivalent contractions and relaxations of the muscular fibres forming their walls. These movements are singularly well-defined and distinct, rapid and regular. In other words, there are here short and abrupt periods of alternate activity and repose exhibited in an orderly manner.

The muscles concerned in respiration act with like order and regularity, and so the movements of the chest are also rhythmical. Every one recognises this orderly succession of actions, in a state of undisturbed health, in the breathing as well as in the pulse.

The same regularity of action, however, occurs in many other parts, but as these are not naturally exposed to view, and as the movements are less vigorous and distinct, they are more likely to escape casual observation. Many kinds of tubes in the body, the purpose of which is to transmit various substances, accomplish this by the assistance of muscular fibres contained in their walls. The intestines act in this way; so do the ducts of glands, and at least the smaller arteries and veins. When these tubes are carefully observed, orderly waves of contraction may be seen to sweep along them in regular succession. The rate at which these waves travel, and the rapidity with which they succeed each other, vary widely in different instances, but the same kind of action occurs in all. The contractions are called, in this case, peristaltic or vermicular, for similar movements, produced in the same way, are witnessed in worms and caterpillars. The direction of the movement depends on the mode of arrangement of the muscular fibres and the order of their action.

It may be well, in passing, to dispose of an error to which the observation of these interesting movements has given rise. It has been affirmed by the highest authorities that because this kind of action is persistent throughout life, and never interrupted by periods of prolonged pause, therefore the muscles concerned in it have no need of repose. It has been argued that because the heart and the muscles of respiration act during sleep as well as when we are awake, therefore, not having, they cannot require, rest. But surely, in this view one side of the subject is altogether overlooked. Is not every interval of active contraction a period of rest? For instance, although it is quite true that we say the heart is always acting, this action, strictly speaking, is not continuous, but intermittent. Every part of the organ is subjected to alternate intervals of contraction and relaxation, to say nothing of the possibility that only some of the fibres of each part act at one period, while others are passive. The same may be said of the muscles concerned in the act of respiration, and of the plain or unstriped muscles generally. No; it cannot be affirmed that the law of rest is in abeyance anywhere.

Much thought has been expended on the nature of rhythmical action, but that the result has been hitherto so unsatisfactory may be due to the fact that these movements have been regarded from a wrong point of view. They have been, for the most part, assumed to be peculiar; to be some kind of action quite distinct in its nature from that of muscles generally. But if it be true that the natural life and healthy state of every muscle involves alternate periods of exercise and repose, would it not seem that the simplest form in which these successive periods occur would be an orderly and regular one? Would it not be more in accordance with larger views to regard rhythmical motion as the primary form of muscular activity, and from this starting-point to attempt to trace some of the various causes to which deviations from it are due; to study, for instance, the relation between the development of a nervous system and the interruption of rhythm; or, in other words, the means by which disturbing causes can operate from without; in this direction working onward, until the influence of a will appears, which, as its power increases through the higher animals up to man, becomes, of all disturbing causes, perhaps the most potent? At all events, the action of the muscles most directly under its control—the voluntary ones—is the least rhythmical. These only occasionally tend to such form of action when, from some particular cause, the influence of the will is withdrawn.

There is strong evidence for regarding rhythmical movement as the primary form of muscular action. It is the first kind of movement by which contractile substance manifests itself at the beginning of life, and throughout living forms it exists more generally than any other. In truth, it is the one universal mode of muscular action, for in the simplest structures and conditions of life the only movements that can be detected are rhythmical ones. And surely the observation of pulsating vesicles in tiny fragments of protoplasm might suggest that it is not in any special arrangement of an elaborate nervous system that the real cause of rhythm is to be found.

But rhythm—or periods of activity alternating with periods of repose in regular succession—is by no means confined to special instances of muscular contraction. Vital processes everywhere must be represented, not by a straight, but by an undulating line. And while in such a line the primary or smaller waves may be very irregular, the secondary or larger ones will be much more uniform. The periods given to sleep, which is emphatically rest of the higher nerve-centres, are naturally regular. It does not affect the question to refer the regular periods of sleep to the regular alternation of night and day; this is but to say that one instance of rhythmical action is determined by another. This rise and fall is shown too, perhaps, in the fact that death more frequently occurs at some hours of the day and night than at others. The impression has been entertained by many that the greater number of deaths occur in the dawn. In 144 cases collected some years ago from the medical and surgical wards of St. Bartholomew's Hospital, without reference to person or disease, or any other especial circumstance, the exact moment of dissolution was recorded. Taking midday and midnight as the extreme points, it was found that between six in the morning and six in the evening, of the total number only 61 died; whereas, between six in the evening and six in the morning 83 died. Thus, the ratio of the twelve hours of which midnight is the centre is to the twelve hours of which midday is the centre as four to three, or, speaking broadly, it may be said that one-third more died during the night than during the day.

Moreover, there is evidence to show that such undulations of action are not directly due to external causes. There appears to be a diurnal fluctuation of temperature, independently of exercise and repose. In persons kept at rest all day, and in the horizontal posture, there is still usually a regular, though slight, rise and fall in the temperature, and in the excitement of morbid action this is often much more marked. Often, too, it may be observed that during recovery from a state of extreme depression the progress is not uniform. Periods of rapid amendment will alternate with intervals of relapse, several times, perhaps, in the course of a few hours. Regular fluctuation in vital activity on a larger scale may be witnessed during the period of early life. Growth, when carefully observed, is found not to be uniform, but to be, at intervals, now more, now less, rapid. In truth, there is no uniformity, any more than there is stability, in life or nature. Change—constant change—prevails everywhere, and is everywhere subject to ebb and flow. This, in the order of nature, is regular, and it is by this order and regularity that we are enabled to recognise the existence of natural laws.

The Material Agents of Vital Action.—Vital action depends on certain conditions, which are supplied by material agents. The consumption of substance involved in the discharge of function is effected, broadly speaking, by the action of the oxygen of the air upon the several structures of the body. This wearing out, or waste, must be repaired, and the source of the restoration and renewal of our tissues is food. Thus, then, Food, including water, and Air, are the material agents necessary to life.

The urgency of the want of these materials is adapted to their supply. Air is everywhere present, and the act of breathing cannot be delayed. Water, as a rule, is always within reach, and thirst can be borne only for a short time ; but food comes not so directly, and we are constructed to support the deprivation of it for a longer period ; but it is the lot of all, of animals in some degree, and of man more especially, to secure nourishment by labour. "In the sweat of thy face shalt thou eat bread." With all men, whether savage or civilised, the prime object of life is to obtain their daily bread.

The use of food is not so simple a subject as at first sight it may appear to be. The sources of demand for it are various. Although the exact relation existing between them is not yet, perhaps, clearly determined, there can be no doubt that food fulfils two great purposes :—The construction and regeneration of the tissues ; the supply of force for the performance of function : The production of heat.

In considering, therefore, the destination and uses of food, the quantity and quality required, we have to study :—

(1) The subject of Nutrition : the repair of waste and renewal of substance.—Now, it appears that, roughly speaking, the animal body wastes daily, on an average, about one-twenty-third or one-twenty-fourth of its weight. But this proportion is liable to extreme variation by numerous and powerful modifying causes. Among the chief of them may be noticed—

The period of life.—This has vast influence on the proportion of food consumed. The young require much more than the old. This increased demand during the early period of life is due to more than one cause. In a growing animal, of course, there must be a surplus of income over expenditure. But in influence far beyond this, in the early years of life change is more active ; vital processes are more energetically carried on. Growth and development, which are phases of nutrition, demand, of course, an equivalent amount of extra food, but the addition thus required is, in any circumstances, comparatively a very small one. It is true that at the time when growth and development are proceeding most actively the demand for food is greatest ; but there can be no doubt that by far the largest portion of it is consumed in repairing the waste which is then most abundant, and that but a very trivial fraction of the whole is employed in augmenting the weight and bulk of the body. For growth and development, even when most rapidly progressing, are but slow and gradual processes, when compared with the amount of food which is daily consumed.

Constitution and habits.—The amount of food required at any time is largely influenced by rest and activity. The quantity and quality of food which will suffice to maintain the body in a state of repose will prove very inadequate during exercise, for the additional force thus expended, as in the case of a working-man, involves the consumption of an equivalent amount of substance.

(2) Temperature.—Heat is evolved by the combination of the elements of the food, and of the tissues which are derived from it, with oxygen. All food, therefore, sooner or later, by combustion, produces heat: some portion more directly after passing into blood; some less directly, only after having formed tissue. So that the amount of heat required influences the quantity and quality of food.

Man belongs to that class of the animal kingdom which is called " warm-blooded." There is a wide difference between various classes of the animal kingdom in the amount of heat they are able to generate and the temperature they maintain. We speak familiarly of animals with warm and cold blood; and these terms, although insufficient, refer to a most important distinction. Those members of the animal kingdom which are called warm-blooded, such as birds and mammalia, have the power of maintaining an almost uniform temperature in the midst of extreme fluctuations around them, and this, by virtue of their great capability of generating heat; whereas those members of the animal kingdom which are less aptly termed cold-blooded, such as fishes and reptiles, have comparatively little power of maintaining an independent temperature. Within certain wide limits, their temperature varies more or less with that of the surrounding medium. Thus, the two classes—between which, however, no abrupt line of demarcation can be drawn —are distinguished by their relative power of resisting changes of temperature. They are also distinguished by their relative power of endurance; for warm-blooded animals appear to be deficient in power of endurance, as cold-blooded ones are in power of resistance. If by any extreme means the temperature of a warm-blooded animal be raised or depressed only a few degrees, a fatal result will be before very long produced. Thus, while the one class can resist much, but endure little, the other class can endure much, but resist little. The powers of resistance and endurance are most variable, but ever, it would seem, inversely proportioned. It is easy, then, to understand what great difference there must be in the amount of heat-producing food which is consumed under these different conditions, and how large an amount of heat must be constantly evolved in the human body.

The amount, however, must vary with the external temperature, as with the season and climate, for it is obvious that in order to maintain an uniform standard more heat must be generated in cold than in warm weather. Hence, more heat-producing food must be consumed. A careful study of the diet in different latitudes, when all the circumstances of each case are fairly taken into consideration, fully bears out this significant fact.

The remarkable and almost singular power of the human race to exist and flourish over the whole surface of the earth depends partly on the temperature which man is able to maintain under extreme conditions of exposure, and partly on his capacity of feeding and thriving on very various kinds of food. Man is conspicuously omnivorous. Animals, for the most part, are either carnivorous or herbaceous, and very few indeed approach him in the ability to digest with impunity and advantage almost every kind of meat, fish, vegetable, grain, and fruit.

Most of the various substances employed by man as food are of complex composition, and contain materials which differ widely in the part they play in relation to the structures and functions of the body. It is convenient, and indeed necessary, to arrange these several materials into separate groups according to their composition and destination when taken as food.

Food, then, may be first of all divided into solids and water. For, of course, properly speaking, water is a most important part of food. Solid food must be reduced to a state of solution before it can be used in the nutrition of the body, and water is the universal solvent. Moreover, no changes in the body—the condition on which all vital action depends—could occur without water. Strictly speaking, therefore, water is of the first importance as food.

The solids of the food may be divided into organic and inorganic substances. This distinction is a necessary one; for man, in common with all other animals, has no power of converting inorganic into organic matter. This is the great physiological distinction between animals and plants. Plants can convert inorganic into organic substances; and out of carbonic acid, water, and ammonia they form the various vegetable tissues. In animals this power of conversion is far more limited, and restricted to certain changes in organic substances. Nevertheless, in them, including of course man, inorganic substances are necessary to the constitution of tissues, and therefore to life and health. Inorganic salts of various kinds enter into the constitution of every structure, and can be derived only from without.

The organic substances, again, must be divided into those which contain nitrogen in their composition and those which do not. The latter—the non-nitrogenous substances—are not, for the most part, capable of forming tissue; at all events, not those tissues which contain nitrogen; for the power of converting a non-nitrogenous into a nitrogenous substance, if possessed by animals at all, is undoubtedly very limited. Non-nitrogenous substances, therefore, can only form fat, which needs no nitrogen, and their plastic or building-up power is restricted to this substance. But, by virtue of their carbon, they are chiefly concerned in the production of heat. This kind of food is, therefore, often called calorifacient. There is, however, as we have seen, evidence to show that, although non-nitrogenous food cannot form the substance of muscle, yet that it may yield force to it. But when non-nitrogenous food is further examined, it may be again sub-divided into those substances, such as starch and sugar, in which the oxygen and hydrogen exist in the proportion to form water; and into those, such as the oils and fats, which contain an excess of hydrogen over oxygen. This, probably, is of importance in reference to their relative power of producing heat.

Fat, therefore, when oxydised or burnt, stands in the front rank as a calorifacient substance, and this by virtue of the excess of carbon and hydrogen over oxygen which it contains. The combustion of a given weight of hydrogen would, as every one knows, give out far more heat than the combustion of an equal weight of carbon. Now, of the fat which is taken as food some is forthwith oxydised, and some may be for awhile stored up as fat in the body. Its immediate destination depends on circumstances, the chief of which is probably the immediate need of the system for heat. The fat of the body may, therefore, be regarded as a store of combustible matter, ready to be drawn on in case of urgent need. In a starving body, the maintenance of the temperature of which is the first consideration, the fat must rapidly disappear. But fat stored up as adipose tissue, which consists essentially of clusters of minute cells, each filled, at the temperature of the living body, with fluid fat in the form of oil, plays an important part by virtue of its physical characters. By its softness and elasticity it is admirably adapted to envelop and protect delicate structures—witness the mass of fat, for instance, which exists between the eyeball and its socket; and by the resistance which it offers to the passage of heat, it plays an important part in retaining the temperature of the body. The fat, which lies immediately beneath the skin, the subcutaneous adipose tissue, as it is called, is especially useful in this respect. Very lean persons are, therefore, apt to feel cold more quickly than fat ones. The blubber of the whale and porpoise has much to do with maintaining the difference between their warm blood and the cold water; and in such animals as the hare, where much fat would be an encumbrance to the activity on which their safety depends, the want of it is compensated by a remarkable fur, which has an almost singular power of retaining heat.

It remains to be observed that the fats of the food, although the principal, are not always the sole source of supply of the fat of the body. It may be formed from amylaceous and even from nitrogenous substances.

Lastly, the nitrogenous food must be divided into the albuminous and gelatinous, for in their destination and uses the albumens rank far above the gelatines. In fact the latter, although they contain nitrogen, have little if any power of nourishment, and the comparatively insignificant purpose they serve is probably rather in relation to the production of heat than in construction; but the albumens or proteine substances—so called from a substance which may be obtained from them—by virtue of their composition, are eminently plastic. They are the direct source of the supply of flesh.

The absolute and relative value of the various substances commonly employed as food depends on the proportion in which these several principles are contained in them.

The use and destination of food, then, is a large and important subject. It is required for the repair of waste; at times, for more than this: for growth and development. It is also required for the evolution of heat. The most economical food is that which is most accurately adjusted to these two conditions. Practically speaking, in ordinary circumstances at least, calorifacient food cannot form flesh. On the other hand, if it be deficient, plastic food must be wastefully consumed in the mere production of heat. The point in practice is to adjust the absolute and relative proportions of the different alimentary materials to the conditions required to have enough of each and an excess of none.

And it must not be forgotten that the quantity and quality of food consumed is determined by the amount of work done. The work required to carry on the organic processes of life is subjected to little fluctuation; for its regulation is beyond our control. But it is the exercise of the animal functions—the expenditure of muscle and nerve force, which varies so extremely—that determines the demand for food over and above the amount needful to maintain the condition.

The other material agent necessary to life is air. The atmosphere is principally composed of the two gases, oxygen and nitrogen; for the minute quantities of carbonic acid and ammonia, watery vapour, and other substances present may now be set aside. Of these two gases, oxygen is the active, nitrogen a passive, agent. The latter takes no active part in respiration. At each inspiration a certain quantity passes in with the oxygen, and at each expiration a nearly equal quantity is expelled unaltered. But oxygen, the active agent, is destined to combine with the elements of the food and of the tissues; for the most part, of course, with carbon and hydrogen, producing carbonic acid and water. The result of this combination, this oxydation, is that consumption of substance which is involved in all vital action.

Now, broadly speaking, it may be said that, on an average, between 350 and 400 cubic feet of air pass through the lungs daily, and that out of this about 20 cubic feet of oxygen are absorbed.

An easy expiration expels, as we have seen, from 20 to 25 cubic inches of air, and this contains, on an average, at the ordinary rate of respiration, from 3½ to 4 or 4½ per cent. of carbonic acid. A deep expiration may yield as much as 6 or 8 per cent. Hence, as we respire from fifteen to eighteen times in a minute, about 160 grains of carbon are excreted each hour; or, on an average, about 8 ounces in 24 hours; the quantity varying, however, from 7 to 14 ounces. It is not so easy to determine the amount of hydrogen which is oxydised and the quantity of water formed, and considerable doubt exists on this point.

The purer the air the better is it adapted to respiration. Of all impurities, that which is by far the most frequently encountered is carbonic acid, the almost universal product of combustion, the abundant product of every flame and breath. Now, careful experiments clearly show that, in proportion to the amount of carbonic acid which already exists in the air, so is the elimination of this poison—for if retained in the blood it acts as a positive and energetic poison—from the lungs obstructed. Therefore, if we are compelled to respire over and over again the same air, all means of ventilation being prevented, the proportion of carbonic acid exhaled is gradually reduced at each successive respiration. When the amount in the air reaches a certain level, about 10 or 12 per cent., no more can be thrown off from the lungs. While 5 or 6 per cent. cannot exist without danger to life, half this amount will prove fatal if formed at the expense of the atmospheric oxygen. In order that the carbonic acid in the air should not accumulate to a degree which appreciably interferes with its free escape from the lungs, it appears that an adult person should be supplied with more than 2,000 cubic feet of fresh air an hour. This fact of the injurious influence of carbonic acid in the air on the function of respiration should be well understood.

The question is very often asked and considered—What is the amount of breathing-room which, as a minimum, should be allotted to each person, as in a dormitory, for instance. A little reflection will show that this does not admit of a precise answer, inasmuch as everything must depend on ventilation. But, at any rate, perhaps it should not be less than from 800 to 1,200 cubic feet.

There must be a definite relation in amount between the food and oxygen consumed. Thus, to take a striking illustration, small animals, in proportion to their bulk, consume many times as much food as large ones. So with oxygen. It has been shown that the consumption of oxygen by small birds is proportionately many times as great as by large ones. The rate of life varies, and the dependence of life on food and air will, of course, be most immediate where the vital functions are most active; while the creatures who live most slowly can exist longest under deprivation.

The Relation of Physical Forces to Vital Action.—No view of life can be at all adequate which leaves out of notice the relation of vital action to the physical forces—heat, light, and electricity.

The operation of these forces is most strikingly shown on the simpler forms of life; for they are more readily influenced by causes acting from without. It may be well, therefore, to glance at some of them.

Every one knows that seeds may be preserved for centuries without any apparent change, and then at length that they will germinate when certain conditions are supplied—air, water, and warmth. Each of these is necessary to vital action; if either be withheld, it remains in abeyance. A seed may be supplied with air and moisture, but its development may be arrested by a reduction of temperature. Heat is essential to this: without it there is no sign of life; all is still. As with the seeds of plants, so also with the eggs of animals. And among the simpler forms of animal life, many in the adult state may be reduced to a condition of suspended animation by a low temperature. Observations and experiments on rotifers, snails, caterpillars, fish, frogs, and snakes, afford ample proof of this.

The condition just alluded to, which has been termed dormant vitality, may be studied in various degrees, from its most complete form, where all change is in abeyance, as in spores, seeds, and eggs, and the simplest members of either the vegetable or animal kingdom, to the phenomena of hybernation; and through this, what has been termed winter sleep, to the ordinary sleep of the highest animals, including man, where there is but a slight and transient reduction of vital activity. Nor does it appear, from any well-authenticated and trustworthy facts, that in man vital action in the whole body can be reduced for any lengthened period below the condition of profound sleep; for in him life so directly depends on vital action that it soon ceases to exist when this is interrupted.

Plants, at every period of their existence, bear abundant testimony to the same influence. The effect of the seasons on their life is an almost universal and ever-recurring illustration. The fact is also set forth in the obvious relation which prevails between the flora and temperature of different latitudes from the pole to the equator; or at different altitudes, from the level of the sea to the mountain-top. As in the vegetable, so in the animal kingdom. A definite relation prevails between the fauna and temperature of different regions. Researches on the geographical distribution of crustacea, for example, have shown that, as we pass from the polar seas towards the equator, they become more abundant and larger; that varieties of form and organization are more numerous, characteristic, and important; and that species increase.

The influence of temperature is very marked on the respiration; that is, on the demand for oxygen and the evolution of carbonic acid, which may be taken as an indication of the rate of life; and the meaning of this influence is set forth in the contrast, in this respect, between warm and cold-blooded animals. In fishes and reptiles, the demand for oxygen varies, within wide limits, directly with th temperature. In a frog, for example, when the temperature around it is gradually reduced, its respiration declines in a corresponding degree to a certain point, which appears to be the limit of its endurance. If the temperature be then still further depressed, the respiration will gradually rise, for an effort is then made to resist further reduction.

But in warm-blooded animals—birds and mammalia, of course including man—which cannot endure any considerable range of internal heat, the respiration varies inversely as the temperature. They resist variation, maintaining an equilibrium by evolving more heat as more is lost. But in all animals, whether warm- or cold-blooded, the duration of life, both of the body generally and also of individual structures when deprived of oxygen, is inversely as their temperature. For the vital activity of every structure varies with its temperature, and in proportion to its rate of life is it more or less immediately dependent on a due supply of oxygen.

The influence of light on vital action is more subtle than that of heat, and therefore it is not so easily recognised in the higher forms of animal life. It is more obvious in plants, for it is through this force that plants are enabled to discharge their characteristic function of decomposing carbonic acid and appropriating carbon. The production of colour is the most striking effect, and this may be regarded as a fair exponent of their vital energy. Thus, plants display the most vivid colours under the influence of the brightest light, and become etiolated when deprived of it. But all must be familiar with many exquisite illustrations of the operation of light on the various vital processes of plants; with its influence on growth and development; on the direction of leaves and branches, stems and roots; and on flowers and fruit—in a word, with its power over form and beauty and vigour everywhere.

To the simpler forms of vegetable life, it appears that intense light may even be excessive. Thus some, at least, of the cryptogamia flourish most in northern aspects, where they escape the glare of a southern sky. Fungi, especially, as every one knows, live best in darkness; but this exception goes to prove the rule, for they differ in their mode of nutrition from other members of the animal kingdom. They do not appear to possess, at least in a degree corresponding to that of plants generally, the power of converting inorganic into organic substances; and like animals, and certain other plants, they digest organic matter. Germination also proceeds in darkness, and a similar explanation holds good here, for the embryo at first does not live on inorganic matter, but subsists for a while on the store of organic matter laid up for it in the seed.

It is interesting to observe that in the animal kingdom, as in plants, the influence of light is most marked in the production of colour. In the case of shells, for instance, where the animal has lain for some time half concealed under the shelter of a rock or sponge, the part of the surface shut off from light has remained comparatively colourless, while the part exposed has been brilliantly tinted.

The well-known chameleon presents a striking example of the influence of light on colour; but effects somewhat similar, though less marked, may be observed in the common frog. When a frog is kept in darkness, the surface becomes comparatively dusky; but on exposure to bright light, paler and clearer. In the skin are scattered a vast number of stellate or branching cells containing pigment in the form of granules, and the various shades of colour which the animal exhibits in different circumstances are connected with the manner in which the pigment is arranged. Sometimes all of it is accumulated in the centre of the cell so as to leave the branches clear and colourless. At other times the whole of the cells, even to the very extremity of the rays, is uniformly occupied by the diffused pigment. In the former case, to the naked eye, the skin appears pale, in the latter darker. In many animals in which changes of colour are conspicuous, and whose widely-varying hues are often very beautiful and brilliant, as in some fishes, these changes are due to the movement of the pigment in their colour-laden cells.

Surely facts such as these cannot be without application to the case of man. In him, indeed, there is abundant evidence of a very direct kind of the operation and influence of heat. The uniformly high temperature at which the body is maintained in spite of very wide variations of external exposure—a temperature of about 100° Fahr. alike in the tropics and at the poles—and the certainty that this bodily temperature cannot vary much for any time without fatal mischief, is significant enough. Nor is the interest of it lessened because the means by which heat is evolved is among the best understood of physical facts. It is clear that in our bodies heat is produced by the combustion of fuel; by the union of oxygen with our food and tissues, and that the temperature is regulated and rendered uniform by the action of the skin and lungs, especially by the adjustment of the perspiration to the heat produced within and existing around us. The practical lesson thereby taught is concerned with this adjustment. It is sufficiently clear that the lower the external temperature, the greater need is there of increased production of heat from within. This involves, of course, oxydation, which mainly depends on exercise. And for those in health and of sufficient vigour, this is beyond doubt the best means of meeting the demand.

But when the needful exercise cannot be taken, then still heat is necessary; and if the requisite amount cannot be forthcoming from within, it should be supplied from external sources. The temperature of the surrounding air may be duly raised, or by appropriate clothing the loss from the surface may be curtailed. The more robust the health, the greater the vital vigour, or, in other words, the more active and thorough the changes in the body, so with the greater impunity can excessive or sudden fluctuations of temperature from without be encountered. But such wide and abrupt variation of external temperature tells too often mischievously on the very young and very old; on infants, who cannot make their substance burn faster by exercise; and on the aged, whose processes are already flagging. If these must be exposed to cold, they should be protected by warm clothing. The reports of the Registrar-General at different seasons of the year set forth this subject in a very impressive way.

But the influence of light on human health is not so clear, or at all events not so obvious, to ordinary observation; and yet there is strong evidence in this direction also. It may, indeed, be fairly argued that a force so potent on the simpler or lower forms of life is not likely to be without influence on us, but evidence of it may be brought nearer than this. The chief difficulty in producing it lies in the fact that changes in the degree of light to which we are exposed can hardly ever be separated from other conditions which are associated with them. In crowded towns, for instance, the poorer classes, and especially their young, live habitually in much less light than the poorer classes and their young in the country. But here, of course, comes in also the difference of air; its freshness and freedom from foul contamination. Then, again, there is the advantage in the vigour of persons who live all day out of doors in comparison with those who are confined to dark rooms; but here also the question is complicated by the influence of active exercise and the want of it. Perhaps some evidence may be drawn from the natural or instinctive love of light of the young and healthy.

Now, what part do these physical forces play in the operations of life? What relation do they hold to those forces whose play is recognised only in the living body, and which are, therefore, called vital forces? Is there the same relation between the several vital forces as there is between the physical forces, and are even the vital and physical forces related in the same way?

Neither plants nor animals have any power of creating matter: they can transform it only. Their relative power in this respect constitutes an important distinction between them. And, as with matter, is it not with force, that it is not created by living beings, but in living structures only transformed?

In vital action, opposite and compensating changes are in progress; ascending and descending ones. In the construction of tissue there is progressive change of matter. It is thereby raised to the level of living structure, and this involves the consumption of force. In the discharge of function there is retrograde change of matter. As the necessary condition of the evolution of force, it descends until it reaches the level of the inorganic plane.

This may be roughly illustrated by the winding up of a clock and the consequent descent of the weight or uncoiling of the spring. In winding up, the weight is raised by an external force—muscular exertion—through a certain arrangement of parts. Then, as the weight descends, the clock goes; it discharges its function; it works. And the force by which the weight descends and produces motion of the hands is exactly equivalent in its total amount to, although expended more slowly than, the external force by which it was previously raised.

Many illustrations might be offered of the relation between physical and vital forms of force; but the result of one very beautiful experiment—from which it would appear that the incidence of light on the retina produces electrical changes similar to those resulting from the stimulation of an ordinary nerve—may suffice.

It has been shown that an electrical change takes place in the retina and optic nerve whenever the former is affected by light. "When the electrodes of a galvanometer are placed, one on the cornea and the other on the posterior surface of the eyeball, or on the transverse section of the optic nerve, the galvanometer indicates the existence of a current corresponding to the so-called natural nerve currents, the cornea being positive; and this current undergoes a variation when light falls upon or is withdrawn from the eye." The same action may be shown by simply placing one electrode on the cornea and the other on some portion of the surface of the body. Now, "currents may be observed between the sclerotics and optic nerve after the removal of the retina, but these are wholly unaffected by light." Whereas the changes due to light appear to be in proportion to the functional activity of the retina.

At all events, if this suggestion be rejected, science must be at present altogether silent on the nature of vital force. For if this be not force derived from without and transformed, whence does it come? what is its source?

Philosophy has, happily, done with the notion of a vital principle; a power the existence of which was first of all assumed, and then to which was referred every thing mysterious and incomprehensible. Nay, even actions that could be otherwise explained by the operation of known causes were not. Indeed, some still recoil from the idea of referring any of the processes of the living body to forces the play of which is recognised everywhere else in nature. Of course, much prejudice has been mixed up with this great question. Many have denounced every attempt to explain any of the phenomena of life by the operation of physical forces; but with what reason? Any conception of life, even at the best, is indeed inadequate and feeble; but is this strengthened or exalted by referring vital actions to some peculiar principle? Is the idea of life made less worthy by the recognition in vital action of forces drawn from without? In any case, physiology can no longer fall back idly on a vital principle, for this explains nothing and checks enquiry.

Too much assumption is evident in the language of those who would persuade us that the nature of vital action is beyond the reach of investigation. Many talk, for instance, as if their power over force and matter were limited only by life. But can we construct a crystal any more than a "nucleated cell?" We may fulfil certain conditions under which, as we have learned from experience, crystals are formed; but what is our share in the act? In like manner, we may take a seed or an egg, and place it in circumstances in which it will develop. In either case, we understand that certain conditions are necessary, and we fulfil them. We can do no more. It is our own fault if the fact be not thoroughly impressed on us that our power does not reach to the level of life.

Death.—The certainty of death and the uncertainty of life: let us devote a few moments to the consideration of this. "A very little experience," says Sir Thomas Watson, "in the sick chamber, or in the wards of a hospital, will suffice to teach you that, although all men must die, all do not die in the same manner. In one instance, the thread of existence is suddenly snapped; the passage from life and apparent health, perhaps, to the condition of a corpse is made in a moment. In another, the process of dissolution is slow and tedious, and we scarcely know the precise instant in which the solemn change is completed. One man retains possession of his intellect up to his latest breath; another lies unconscious and insensible to all outward impressions for hours or days before the struggle is over."

The proximate cause of death is the failure of some function the due performance of which is necessary to life. When any organ is damaged, the effect will be in proportion to the importance of its function in the economy. Its defect or loss may produce inconvenience merely, either from its comparative insignificance or because its function may be discharged vicariously by some other part, as, for example, in the case of a limb, or of the spleen; or it may lead sooner or later to death as life is more or less directly dependent on its function, as in the case of the stomach, lungs, heart, or certain nerve centres. The relation in which life stands to those functions on which it depends varies extremely. In some instances it is so remote that death follows their interruption only after a prolonged interval. In some it is so close that death immediately succeeds their suspension.

Now, there are organs which stand above all others in this respect—the heart, the lungs, and certain nerve centres included in the term brain. Life depends directly on these because they are directly concerned in the circulation of pure or arterial blood. Hence, death may be said to begin at the heart, lungs, or brain respectively.

The heart is the great agent in the circulation of the blood. In man and the higher animals all the other forces concerned are quite subordinate to the action of the heart, so that practically the circulation depends on the force of the heart's action, and fails when that gives way. Now, the heart may fail to circulate the blood from inherent causes. Its structure may become so altered that it is no longer capable of contracting with sufficient vigour, as, for example, when its muscular fibre degenerates into fat. In many cases of sudden death, and in others, too, in which death supervenes more gradually, the structure of the heart is found to be wonderfully changed. The fibre presents no longer the aspect of muscle, but appears to consist only of minute globules of oil; and the mystery of such cases as these is, not why the heart ceased at length to beat, but how, thus damaged, it continued to work so long. Or, again, in consequence of this or of some other change, the walls of the heart may be ruptured or torn; and in these cases, in which the heart is literally broken, its function is, of course, forthwith arrested. These, then, are cases in which death begins immediately at the heart. Death through faintness or by syncope.

But the action of the heart may be stopped by causes which operate through the nervous system. That the heart may be powerfully and even fatally influenced through the nervous system is familiar knowledge. It is no mere figure of speech, but plain truth, to say that the heart will leap from joy or sink from fear, and emotions in a still stronger degree may check its action sufficiently to cause death. Thus, some have died from fright; and other sudden and powerful impressions in the form of violence may act in the same way. In these cases, death begins at the heart, but not immediately. The cause acts through certain nerve centres. Death from shock.

Or death may begin immediately at the lungs. Venous or impure blood is changed into arterial or pure blood in the lungs where it meets with atmospheric air. If this change be prevented, the circulation through the lungs, and consequently elsewhere, is checked. Thus death occurs in strangulation or suffocation, for here air, which is essential to the change on which the circulation depends, is shut out. If the occlusion be sudden and complete, the circulation is rapidly arrested; if it be but partial and gradual, for awhile an impure blood languidly circulates, and the sequence is prolonged and complicated. But in either case death begins directly at the lungs. Death by asphyxia, or, more properly, by apnœa.

But in the higher animals there is an elaborate apparatus for the introduction and expulsion of air. Certain muscles, the principal of which is the diaphragm, are arranged to act in such a way as to enlarge the capacity of the thorax, and thus expand the lungs in inspiration, and this is immediately followed, when these muscles cease to act, by a recoil of the thoracic walls and lungs in expiration. Now, the action of the inspiratory muscles, it may be remembered, is thus induced: when venous blood flows to the lungs, the impression it makes there is transmitted through certain nerves to certain nerve centres, whence it is reflected through other nerves to the muscles in question, in obedience to which they contract, and effect inspiration. Therefore, the integrity of certain nerve centres is essential to the response of these muscles to the signal at the lungs. When these centres, then, are destroyed by injury or damaged by disease, the most important link in the chain is wanting. In vain the venous blood accumulating in the lungs produces a powerful impression there. However urgent, it cannot be reflected to the muscles. So, no movement follows; no air can enter; the blood stagnates; and death ensues. Thus people die with broken necks, and in most fatal cases of apoplexy. In these cases also death begins at the lungs, but not directly. The cause here acts through certain nerve centres. Death by coma or stupor.

Thus death begins at the heart or lungs, either immediately, by syncope or apnœa, or through certain nerve centres, and death may be produced through these nerve centres in two ways: either by the heart, as in sudden death from shock; or by the lungs, as in slower death by coma.

But death may result either from a loss of the quantity or a defect in the quality of the blood. When these causes produce death, whether rapidly or slowly, it is chiefly through the nerve centres; because these organs, beyond all others, are immediately dependent on a due supply of healthy blood.

The distinctive features, the signs during life and appearances afterwards, of each kind of death or mode of dying, are most clearly marked in those instances in which the effects are most rapidly produced. Usually, the more protracted cases are less simple ones, for during their course one mode of dying is liable to be complicated by the intervention of causes which tend to death in a different way. So, in many cases, in fevers, for instance, what may be called mixed forms of death are often witnessed. Still, even in these, the tendency to one particular mode of death is usually prominent.

The change from life to death must be most impressive to every one; but when closely studied it is not so simple or abrupt as it may appear to be to casual observation. It has been already seen that the life of the body is made up of the lives of numerous and diverse structures; that while all these work in harmony, and minister to one common end, the life and health of the individual is secured. So that within the general life, or the life of the whole system, there is the special life of every organ and structure; and as the life of every organ depends for continuance on its relation to the rest, so is the life and health of the whole body more or less directly dependent on that of every organ. If any organ, as, for instance, the heart, be separated from the body, it can live only for a short time. That it lives at all after separation demonstrates the fact of its own individual life; that it soon dies demonstrates the dependence of its life on other organs. And when the heart is removed, the rest of the body forthwith dies, wherefore this and other organs, the action of which is essential to life, are called vital; for there are others of subordinate purpose, the removal of which does not necessarily involve loss of life of the whole. But the word death has a still wider range of signification than this, for, as we have already seen, during the active life of every structure there is, and this as the necessary condition of it, constant destruction of its particles, or molecular death.

Hence it becomes needful to speak of general, or systemic, or somatic death; and particular, or special, or molecular death. After the final cessation of certain functions on whose continuance life depends; after the last pulse has beat and the last breath has been drawn; after a person has expired, and when, to an ordinary observer, all is still within; yet for awhile life lingers here and there in various structures and organs. After the general death of the body, vital action still persists for a time in individual parts. Vital action may be clearly and unequivocally shown to exist for variable, even for prolonged, periods in different structures. Thus it may be understood how certain individual functions may be discharged for a time after death of the body; how, for a time, muscles may continue to contract, nerves to convey impressions, glands to secrete.

This distinction between the life of the whole and of its several parts, which thus is apparent even in man, becomes vastly greater in the lower forms of animal life. In the simpler animals, the several functions are less separated—there is less division of labour; consequently, each part possesses to a corresponding extent the conditions which are essential to its life. In the simplest forms, where there is little, if any, division of labour, any one portion may live apart from the rest, for all the functions of the animal, such as they are, may be said to be performed by every part of the organism. Thus, by division of the simple substance of an amœba, the animal is merely multiplied; each fragment becomes forthwith a whole. So with the common hydra. It may be divided and sub-divided, literally minced, and each part grows into a distinct animal. Not only can each fragment maintain its life, but it can accomplish growth and development, the highest phases of it. Even in animals far beyond these, the same wonderful power, though to a less degree, is possessed. Many worms, when divided, have the power of reconstructing the whole from a part, and no study can be more interesting and instructive than to trace the gradual manner in which this power dies out as we pass from the simpler to the more complex forms, until at length in man the last faint, yet important, vestiges of this capacity are exhibited. Fingers, toes, ears, and noses, when completely detached from the body, and re-applied at the divided surfaces, have re-united and become restored, and this in some cases even when they have been separated for a considerable time. During the interval of the separation of these parts they must, of course, continue to live, for if they perished it need not be said that subsequent union would be impossible, inasmuch as in no circumstances could a dead part be made to unite with a living one.

Upon this principle, a portion of the living body may be transplanted from one part to another; an operation akin to grafting in plants may be successfully performed.

Death from old age is very often spoken of, but in the proper sense of the expression it is very rarely, if ever, seen. It is easy to imagine that, in the construction of the body, the strength of its various organs, and their relation to each other and to external conditions, shall be so precisely adjusted that they may gradually wear out at the same rate, and at length cease working together. But when does this actually occur? In all probability, the very great majority start in life with structures and organs of unequal strength, with some one or more weaker than the rest, and liable to fail prematurely from various adverse or disturbing causes. But assuming that, at the outset of life, the several organs are equal in strength and capability of endurance, still, in the course through life, in their relation to surrounding conditions, they must become very variously affected. Some are almost certain to be more heavily weighted than others, and to yield prematurely to the exceeding strain. Therefore, although death from old age in this sense, from a general and equal decay of vital organs, may occur, yet in fact it is very rarely, if ever, witnessed. But in another sense, death from old age is far more frequently seen. Death, no doubt, is often due to the natural decay of some one or more of the vital organs. Some organ is worn out—prematurely, indeed, in comparison with some others—but its incapacity for any further work is brought about, not by accident or by impairment from what should be called disease, but rather by changes which, sooner or later, will inevitably occur; it is the result of some form of degeneration common to old age. To take an obvious illustration. In advanced life much of the hair is gradually lost, and what remains turns grey and then white. No one would call this disease. It is, for the most part, a senile change. But it may occur prematurely. The hair may present all the characteristics of old age even in the young; and if it were essential to life, death would be the result of old age, *i.e.*, the premature old age of a particular structure. Changes, similar to those which are obvious to all in the hair, not seldom occur in internal structures whose due strength and efficiency of action is necessary to life. In some of the blood-vessels, for example. These possess certain properties by which in health they are enabled to resist the pressure of the blood within them and to transmit it. As life advances, these properties are gradually lost through certain changes which occur in their walls. Such changes are constantly met with in extreme age; but they sometimes occur prematurely, and bring life to a close at a period which ought to be its prime.

Very few, if any, live till all the organs are worn out, and it is interesting to trace the usual order of their decay.

Bichât, throughout his work on "Life and Death," draws the broadest distinction between organic and animal life, and in a chapter on the natural termination of the two lives—that is, death by old age, which he says is rare—he describes how, in the old man, animal life ceases before organic life; how the senses severally fail, and the functions of the organs of relation gradually decline; and how he passes his days concentrated upon himself, a stranger to all that surrounds him, deprived of desires, passions, and sensations, isolated in the midst of nature. Bichât explains this want of harmony in the decline of the two lives by the fact that, owing to our social relations, we use up or wear out our animal life much faster than the organic life. Man, in the midst of his fellows, exerts his animal functions far in excess of his organic. The brain and nervous system, for example, we know are continually subjected to an undue amount of wear and tear. This idea is certainly an ingenious one. Then he goes on to consider how this social influence upon the two lives or systems is, up to a certain point, advantageous for a man; how, by the failure of his senses, he is detached gradually from all that surrounds him, and so he suffers less cruelly at the moment when these ties are severed. He says the idea of our supreme hour is painful because all those functions cease which bring us into relation with that which surrounds us. It is the thought of the deprivation of those functions which spreads fright and terror upon the border of our tomb. He assumes that a man would contemplate with indifference the approach of a death which deprived him only of his organic functions—of the circulation, digestion, and so forth—if the functions of relation were spared to him. So, he says, animal life comes to cease gradually; so each of the ties which enchain us to the pleasure of living are broken little by little, the pleasure escapes us unawares, and when at length a man has become oblivious of the cost, then death strikes him. It is thus in the old age that comes with the successive and partial loss of man's external functions and the total loss of the sense of his existence. His end finds him like a vegetable which fails in relative functions, having no consciousness of its life or knowledge of its death.

Surely there is something inexpressibly gentle in this gradual severance of the links, between the conscious man and the world around him, by the decay of the senses; so that in old age, as death approaches, the dread of it disappears.

But the fear of death is often absent in other instances. Every one, I think, who has frequently stood by the bedside of the dying must have been struck by the freedom from dismay as death draws near. Often, no doubt, the mind is otherwise too fully occupied, perhaps with intense bodily suffering; but even in the absence of this and of all other distracting influences, and with a clear conviction that the approaching change is close at hand, the mind is calm and collected, the thoughts serene; there is usually no quailing, no giving way. We appeal to those who are most familiar with the closing scenes of life whether, in the dying, manifest indications of the fear of death are not extremely rare. And all who are accustomed to hospital practice must have remarked the apathy or indifference of patients as to the issue of the gravest injuries or diseases. The time of greatest mental distress is, perhaps, when the conviction first dawns on us that we are about to die. The subsequent contemplation of approaching death seems to be far less terrible.

Nor can there be much doubt that it is an error to suppose that, in every circumstance, the moment of death is one of agony. Those who have observed most closely declare that it is not so. In certain cases the moment of dissolution may be one of extreme anguish, but these are exceptional. And, indeed, it follows from what has been already said, from the mode in which death supervenes, that the actual process of dying cannot usually be attended by pain or distress. Some, we know, lie insensible for hours or days before death; and even those who retain in some degree the use of their faculties to the last moment cannot be in a condition to experience acute suffering. In order that the nerve-centres, which are the seat of sensation, may discharge their functions, they must be properly supplied with healthy blood. No organs depend so immediately on a due supply of pure blood as these; and when is this the case up to the instant of dissolution? In considering the modes of dying, it has been seen that it results either from deficiency or defect of blood; because either too little is supplied, or that which circulates is too impure. As a consequence of this, the brain, of all the organs, will first fail in its functions. We hear and read of persons retaining a clear and vigorous intellect up to the moment of departure; but, in truth, such beliefs and statements rest on very shallow evidence. A few reasonable sentences uttered at intervals, or the repeated expression of some prevailing idea, can hardly go for so much.

But true is the instinct of love which bids us fondly cling to parting words; for we may reasonably believe that the thoughts and sentiments which linger longest are, beyond others, vivid and intense. As the mind darkens, the ideas that rise above the rest catch the last rays of intellectual light.

Again, many of the supposed signs of great suffering are not really such. The cold dew on the face and surface generally, the collapsed and perhaps distorted features, the heaving, gasping, or gurgling respiration, or, it may be, the convulsive agitation, are by no means necessarily the signs of pain and distress. Therefore, whatever may have been the degree of previous suffering, it may be fairly assumed that, except in extreme cases, the actual process of dying is not one of intense agony; or, indeed, for the most part, even of pain. Every one knows that simple faintness may pass into death, and those who have been recovered from the verge of dissolution, long after all consciousness or sensibility has ceased, have borne testimony to the same effect.

In some cases, no doubt, when life is suddenly destroyed by injury or violence, the actual pangs of death are most acutely felt; and as a physician will often at a glance read the nature of the disease in the patients' faces, so we may observe varying expressions of countenance immediately after death. For example, on the field of battle the corpses of those who have died of stabs are, we are told, easily distinguished by the countenance from those who have fallen by gunshot. The painful expression that remains on the faces of the former contrasts with the serene composure on those of the latter. And this holds good to no less degree in disease; and when we remember how calm and placid the aspect of death commonly is—

> "Before decay's effacing fingers
> Have swept the lines where beauty lingers"—

we may well take comfort from

—"The mild, angelic air,
The rapture of repose that's there."

We may glance for a few moments at the signs of death. After death, the body grows cold; that is, its temperature gradually falls until it has sunk to the level of the surrounding air. Sometimes, however, in very exceptional instances, the temperature is maintained or even raised for awhile in a remarkable manner. There can be no doubt that this is due to chemical action; to the combination of oxygen with the elements of the body, which must proceed after death with extraordinary energy. In animals poisoned by strychnia, for example, and in which, therefore, for some minutes before death violent spasms are produced, a thermometer in the body will rise two or three degrees for several minutes after death. Here, no doubt, active changes in muscular tissue, which are, of course, associated with this violent action, are sufficient in the circumstances for a time to raise the temperature. For let it be observed, in order that a temperature after death may be sustained nearly or quite equal to that which prevails during life, it is not necessary that an equal amount of heat be set free after death, inasmuch as the chief means by which the temperature is controlled during life are no longer in operation.

One of the surest signs of death belongs to the muscular system. It is the peculiar state into which the muscles pass at a certain period after death; a state of firm contraction. All the muscles become fixed and rigid, so that the body is stiffened. This condition is known as *Rigor mortis*, or the rigidity of death. It varies in the period after death at which it commences. It may set in immediately, without the lapse of any appreciable interval; or it may be delayed for twenty-four hours, or even longer. It varies also in its duration and intensity. It may be so slight as to escape notice, or it may last for one or two or even three weeks.

Its length of duration and degree of intensity usually go together, and it may be said that, as a rule, when it comes on slowly, it lasts longer and is more marked. The strength and vigour of the muscles before death determine the degree and duration of *rigor mortis*.

Although it is thus very variable, it is probably never entirely absent. It was once believed that it does not occur in certain forms of death, as when persons are killed by lightning, or when death is preceded by excessive exhaustion. But in these and similar cases, it is more probable that it is not altogether absent; but being extremely slight and transient is apt to escape detection.

In relation to this subject some curious but authentic facts may be referred to. On the battle-field a startling spectacle has been occasionally witnessed. A soldier has appeared to be fixed in some strange position—perhaps kneeling with his musket to his shoulder as if about to fire; but on closer inspection he has been found to be dead: a rigid corpse in the semblance of energetic life. The following extract is from a letter of the special correspondent of the *Times* newspaper which appeared on October 11th, 1854. Dr. Wm. H. Russell is describing the scene after the battle of the Alma:—

"The attitudes of some of the dead were awful. One man might be seen resting on one knee, with the arms extended in the form of taking aim, the brow compressed, the lips clenched—the very expression of firing at an enemy stamped on the face, and fixed there by death; a ball had struck this man in the neck. . . . Another was lying on his back, with the same expression, and his arms raised in a similar attitude, the Minie musket, still grasped in his hands, undischarged. Another lay in a perfect arch, his head resting on one part of the ground and his feet on the other, but the back raised high above it. . . . Some of the dead lay with a calm, placid smile on the face, as though they were in some delicious dream."

Instances similar to these were observed on the field of Solferino, and others occurring elsewhere have been from time to time recorded.

After death the blood coagulates. This change, like the stiffening of the muscles, is much influenced by the form of death, the previous state of the individual, and other conditions. And like it, also, this has been supposed not to occur after certain kinds of death, as in those killed by lightning, or in animals hunted to death. But here, again, it is doubtful whether it is entirely absent, although it is often but very partial and imperfect.

It would appear, not only from the conditions which affect them, but from a study of the actual changes that ensue, that *rigor mortis* and the coagulation of the blood are closely related.

The coagulation or clotting of the blood is a remarkable process. Blood when withdrawn from the body in a very few minutes becomes semi-solid or jelly-like, and at first appears quite uniform. But presently drops of a transparent yellowish fluid begin to ooze from the gelatinous mass, and these gradually collect, until after some hours a considerable quantity of fluid, called serum, has been squeezed out. This surrounds the solid portion or clot, which, by contraction, has now become reduced in size and much firmer and denser. The clot consists of the blood cells entangled in the meshes of a substance called fibrine, which has been formed from the liquor sanguinis or plasma during coagulation, and to the subsequent contraction of which the separation of the serum from the clot is chiefly due.

Thus, while living blood consists of cells floating in a plasma, blood, after coagulation, consists of clot, formed of cells and fibrine, and of serum. The serum differs from the plasma in having lost an albuminous substance, out of which fibrine has been formed.

Now, during the onset of *rigor mortis* in muscles similar changes occur. The plasma of living muscle, like the plasma of blood, separates into two portions; into a solid clot called myosin—like fibrine, an albuminous or proteid substance—and a fluid, which is serum.

But these, which in their result are so striking as to be obvious to every one, are by no means the only structural changes that occur in death. More recent researches have made it quite certain in respect of some, and highly probable in respect of others, that structural characteristics which have been ascribed to tissues are due to a *post-mortem* change, and in no way belong to them during life. Living muscle, in a thin layer, is transparent. As the muscle dies, it becomes opaque. The elaborate structure which was formerly attributed to the fibre cannot be discerned in the living muscle, and must now be recognised as the result of *post-mortem* change. Still more recent researches make it probable that the same thing is true even of tendon. Nerves, too, exhibit characters after death which cannot be discovered during life. This has been long understood. In dying, they undergo changes which, at least in feature, may be compared to the coagulation of the blood. And this great fact of molecular change in death applies with equal force to those minute microscopic structures which are known as cells. These are found very abundantly in all plants and animals. The simplest forms of life in both kingdoms are supposed to be built up entirely of cells; and of the most complex and highly elaborate bodies, cells, as cells, form a very large part; while those structures which do not display throughout actual cells, are nevertheless supposed to have been originally formed of cells, which, in the course of development, have been changed in shape and function. Thus arose the famous cell theory, which, as originally expounded by Schwann, has long held undisputed sway over all ideas of structure, function, and development. According to this, "there is one universal principle of development for the elementary parts of organisms, however different, and this principle is the formation of cells." Now, a cell, according to the original notion of it, consisted of a wall or envelope of extremely delicate, transparent, structureless membrane, which enclosed a cavity containing various substances, either fluid or solid, the contents being very different in different instances; and always a distinct body called a nucleus. Thus, there were three parts to be recognised—the cell-wall, the contents, and the nucleus. But even from the first it had to be allowed that a distinct cell-wall to the cell could not always be discovered. Then difficulties followed concerning the distinctness of the nucleus, and in course of time the suspicion arose that the several parts of the cell usually so plainly seen when structures are mounted for the microscope did not naturally belong to it, but were due to some change which the substance had undergone; and now it is more probable that these so-called cells are during life and activity simple fragments of a transparent, uniform, structureless substance called protoplasm, and that the formation of a cell-wall and nucleus may be compared to the clotting of the blood. Even in the so-called blood-cell, whether red or white, when alive and healthy, no nucleus can be demonstrated in any animal.

Lastly, sooner or later after death, and following the changes just referred to, the effect of decomposition appears. The body decays. This, too, in its onset and progress is very variable. The several tissues, of course, differ extremely in the degree in which they yield to change. The contrast is most marked for obvious reasons between hard and soft parts. The muscles disappear, but the bones last for ages.

The rate, of course, and even the character of the change are influenced by external conditions, such as the presence of air and water, and the temperature. Every one can recall proofs of this. Few of those who, when traversing the famous pass of St. Gothard, have paid a visit to the mortuary will forget the ghastly spectacle. There, in the region of perpetual frost, decay after death, at least the ordinary form of it, is almost arrested.

Let it be repeated that death is not distinguished from life by decomposition, but now there is no renewal. There is no longer any compensation for the loss, and the products of decay are not now renewed as fast as they are formed; so the changes that occur, albeit they are slower, are more obvious than the active changes during life. Moreover, the forces thence evolved are only those common to inanimate matter. Thus the decay which follows upon death is plain to all, and everywhere recognised as the clearest proof of it.

Health.—What is to be understood by the term "good health?" If life consists in the performance of various functions all working in harmony and ministering to a common end, then when each function is properly performed, absolutely for its own special purpose and relatively to the rest, the body is in a state of health. On the contrary, when an organ in its working gets absolutely or relatively wrong, there is disorder or disease. But as the term "health" is ordinarily employed, although it is intelligible, probably, for the most part, no fixed idea is attached to it. For instance, take health in its relation to strength. Health and strength of the body as a whole, or of some one or more of its several parts, often go together; and, indeed, more strictly speaking, to say that an organ was strong would imply that it was healthy. But, as the term "strength" is commonly used, it by no means involves the condition of health. A man may be remarkably strong in more than one way; his muscles may be of extraordinary size and vigour, or his brain active and powerful; he may excel as an athlete, or he may be conspicuous for intellectual energy; and yet his death may be impending from a fatal flaw in some vital organ. Such a state, in which health and strength are signally opposed, is not a very uncommon one. Again, one person will live and enjoy life in the midst of hardship and deprivation, will bear exposure and escape risks to which many others would succumb, and yet die prematurely from some cause which appears to arise from within: another person will be throughout his life extremely delicate, never attaining enjoyment of it except at the expense of care and watchfulness; and, perhaps, not even then, yet such an one shall live on into a good old age. But these apparent contradictions disappear when it is remembered that health and the duration of life depend on the health and power of endurance of the weakest of the organs which are necessary to it; that failure of one vital organ cannot be compensated by excess of energy in another whose function is different; and, furthermore, that full, and even extraordinary, vigour of an organ during a great portion of its life does not necessarily foretell a long term of endurance. For a while it may be strong, and yet may very soon wear out. But, although health and strength are by no means always associated, and although, further, health in its proper sense does not always imply, even in the absence of accidental mischief, a long life, yet, in estimating the chances of its duration, it need hardly be said that these conditions are of paramount importance. In any personal examination, then, with a view to determine the state of health and the prospect of life of an individual, the various organs of the body, particularly vital ones, are each in turn carefully scrutinised, and such scrutiny is more anxiously directed now to this, now to that organ, according to the age of the person and the history of his past life; for the liability to disease or defect in the several organs varies with years and habits. For instance, in earlier life the state of the lungs, in later life the state of the heart, is more especially investigated. Such enquiry into the condition of the patient as this is made by every surgeon when any serious operation on him is contemplated. But, with regard to the prospect of the duration of life, another consideration of great importance has to be taken into account.

Every one is aware that children not only derive life from their parents, but inherit also the qualities of body and mind, which are summed up in the expression of "family likeness." This likeness, however modified and controlled by various influences, in some degree, no doubt, always prevails. It may be hardly discernible; it may be most strongly marked. A child may resemble in body, or in mind, or in both, now the father, now the mother; but in every instance, at least in some degree, he inherits not only life, but constitution and character. Guided by this knowledge, those whose duty it is to examine persons with reference to their prospect of life for insurance always carefully enquire into what is called the family history; whether the parents are living and healthy; or, if dead, at what age they died, and from what cause: and similar questions are asked with regard to brothers and sisters. This natural law of inheritance is a large and important one. Every year extends our knowledge of its application, and already it is clearly seen that there is the utmost difference in different diseases or constitutional defects in their tendency to pass from parent to offspring. Of some, there is little or no evidence of direct transmission; of some, the evidence of this is doubtful but suggestive; but of some, as, for example, of pulmonary consumption, it is sadly overwhelming.

No one can reflect on the subject of hereditary transmission of disease without being struck by the great question which it involves. The parent of several children at length dies, at a certain age, of some particular disease—say, pulmonary consumption; all the children appear to be quite healthy, perhaps even robust. They grow up into men and women, whose form and endowments of body and mind leave nothing to be desired; and yet all these children, in uninterrupted succession, each of them, as he or she attains a certain age, or thereabout, die of the disease which proved fatal to the parent. By what means is this deadly influence thus transmitted? How is it that the fatal flaw in the life—"the rift within the lute"—makes no sign of its presence, perhaps, for a quarter of a century; interferes, in no way, for many years with the full vigour of life and health; and then, in spite of every precaution, springs up and rapidly kills? In what direction is a solution of this mysterious problem to be sought? *

But, although the instance of actual disease is the most striking form in which this great question of hereditary transmission presents itself, the difficulties in the way of its solution are not greater than, but the very same as, those which beset the question of the hereditary transmission of natural qualities of character generally. The question why a child should inherit any particular disease from its

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* The above paragraph was written in full view of the recent brilliant research of Koch on the production of tubercle. For, even if further investigation should establish the fact to which this points, the questions we have asked will still remain to be answered.

father or mother will be better answered when we can answer the question how it is that a child should grow up to resemble its parents.

Then the state of health and the duration of life of all individuals will be largely affected by his original constitution. The previous remarks upon the varying rates of life in different persons bear on this. Unquestionably, there is more of vital action in a given time in some individuals than in others. In a strictly physiological sense, some live much faster than others, and die prematurely only if life is to be measured by time, but not if the amount of it may be estimated by action. This difference is recognised in a vague sort of way in different temperaments. Whatever classification of temperaments be adopted, and whatever definition be given of this or that particular kind, the degree of vital activity in each case cannot be excluded from consideration. Nay, whether it be more or less obvious in each case, it probably constitutes the principal feature.

But then the original constitution covers more than the future life-rate. It determines, in the long run, the duration of life by forcing the limit of endurance of some vital or important organ. In the absence of all injury and accidental kinds of destruction, some organ, as already noticed, on which life directly or indirectly depends, at length wears out and succumbs to what, so far as itself is concerned, is literally old age. And in relation to this is probably the fact, which many recognise, that, so far as the duration of life and the maintenance of health and strength are concerned, that physical state is the most promising which may be described as an average one. Exaggeration or eccentricity, or considerable deviation from the usual type, whether of the whole frame or of any important organ of it, is probably not favourable in this respect; although, perhaps, such extreme conditions may represent extraordinary powers in a particular direction. For example, in regard to height and bulk, very tall and large men, as the rule, do not last so long or so well as those of average stature. In proportion to their number, very tall or very short men are far more often badly made than men of average size—say of from five feet seven inches to five feet nine inches in height, and in weight of some 140 to 160 pounds. The men of our fire brigade may be taken in illustration of this. They are, for the most part, of very average height and weight; and in physical excellence, and in attributes which more immediately depend on this, it would be difficult to match them. In the case of any particular organ, excess or defect, or any eccentricity of character, implies a corresponding want of accurate adjustment to the rest; and harmony of action is, as we have already seen, a condition of health.

Every one is aware that the duration of life and the state of health are very largely influenced by the circumstances in which a man lives. In the case of diet, for example, it is understood that the due and proper action of the stomach and liver, and other organs associated with these, depends on a regular supply of wholesome food; that, sooner or later, indigestion waits on error in diet, whether of quantity or quality.

Again, the beneficial influence of pure, fresh air is proverbial; and this, as a rule, is most obvious in the young, for in early life the vital functions respond more rapidly to the influence to which they are exposed. The contrast is striking enough in aspect and bodily health between those who pass their lives in closely-crowded towns and others in the country. Although, no doubt, the greater part of the difference which is here shown in the majority is due to the difference of the air; yet, of course, it is complicated by other influences, which must also be taken into account. The degree of light to which the body is habitually exposed is, as already observed, a more subtle one; and its effect is probably too much neglected. Then there is the question of exercise, and the influence of occupation, which, in many cases, is a directly mischievous one.

As a general rule, the average mortality in this country increases with the density of the population. The death-rate from consumption, typhus fever, and childbirth is far higher in cities than in rural districts. Density of population usually implies poverty, insufficient and unwholesome food, and unhealthy work; but the chief condition associated with it is impurity of air from overcrowding, want of cleanliness, and imperfect removal of excreta. Of course the mischief is most apparent in those who are most susceptible. No one can overlook the influence of change to purer air in promoting recovery from severe illness.

It has been said that it is hardly possible to observe separately the effect of deficiency of fresh air and deficiency of exercise, as these two causes generally act together. But Sir Thomas Watson, in reference to the fact that the diseases chiefly incidental to childhood are twice as fatal in town districts as they are in the country, shrewdly observes: "There is one circumstance which shows that impure air is the more noxious agent of the two—namely, the great comparative mortality in towns of children under two years of age, even although they get as much exercise as their time of life would allow of anywhere."

The supply of external warmth, or the prevention of undue loss of it from within, is a very important circumstance in relation to health and vigour. We have seen that the maintenance of a tolerably uniform temperature is an essential condition of life, and that this is affected by an adjustment of the conditions under which heat is produced and carried off. If more escapes, more has to be generated. The effect of season and climate is marked in this way. Now, as already noticed, in those who can respond to the call, as the young and active, the gradual loss of much heat may, and often does, prove beneficial by promoting change; but in the aged and in infants and feeble persons, and in those who, from whatever cause, are debarred from active exercise, the undue loss of heat may prove very disastrous. This is, no doubt, largely concerned in the excessive mortality at the extreme periods of life in the severer months of the year. But the proper protection of the body in this respect by adequate clothing is a matter too much neglected by many who are in vigorous health. Man, of course, is at a great and peculiar disadvantage in respect to external temperature. Animals are naturally clothed, and those who have not reflected on the subject can hardly appreciate the protection afforded by fur and feathers. Let us take the instance of a very small bird—one of our songsters—during the night of a severe winter. The temperature which surrounds him is, perhaps, for several hours ten or twenty degrees below freezing point. He is during this period at perfect rest, with his head tucked under a wing, a tiny ball of feathers. A thermometer within him would register throughout the night, without variation, a temperature of from 105° to 110° Fahr.: that is, from 80° to 100° above the surrounding medium, and the little creature does not weigh altogether more than an ounce. Think, on the one hand, what a marvellous heat-producing morsel this must be; and, on the other—with the utmost allowance for this—what a powerful protection against escape of heat must be afforded by these few grains of feathers! But man is naked, and needs, at least nowadays, artificial covering to prevent death from cold.

Against, however, the want of this natural means of defence, man is, or at least ought to be, by virtue of his superior intelligence, able to regulate within wide limits the conditions under which he lives; to bring himself, far beyond all other creatures, into harmony with his environments. This he may accomplish, in large measure, by the wise adjustment of the conditions of supply and demand; for example, in the amount of food and exercise in relation to temperature, or, where these fail, in artificial warmth from without, and more abundant clothing. But while from necessity there is very often defect, from choice there is too often excess. Many, perhaps, think too lightly of habitual excess of food from the notion that what is not required will not be used, and so, at the worst, it will prove to be only an agreeable form of waste. But, to say nothing again of the undue burden of work thus thrown on the organs of digestion, if more material passes into the blood than the system can appropriate and thoroughly consume, the excess, incompletely transformed, must linger for some time in the body before it can escape; and the system, thus overcharged with these products of imperfect combustion, is prone to fall into trouble in various ways. Gout, perhaps, in some of its various forms, with its long train of troublesome allies, tells of the furnace overstocked and choked with fuel; of smoke without flame; of the need of less to be burnt or of more oxygen to consume.

The necessity of exercise to the preservation of health is allowed by every one, and yet, perhaps, few realise the importance of the changes it involves. Take, for instance, the effect of muscular exercise on the respiration. In ordinary circumstances of rest, a man draws in 480 cubic inches of air per minute; if he walks at the rate of four miles an hour, this quantity will be increased five-fold, so as to amount to 2,400 cubic inches in the same time. Or to put it in another way. It was found by experiments that a man at rest inspired per hour 27 cubic feet of air. This represents the absorption of 416·8 grains of oxygen, and the exhalation of 603 grains of carbonic acid, equal to 164 grains of carbon. But during exercise, in the same period, he inspired 64·9 cubic feet of air, which represent the absorption of 1,829·6 grains of oxygen, and the exhalation of 2,501 grains of carbonic acid, equal to 682 grains of carbon. From these, and similar calculations, it would seem that fair exertion for ten hours a day would increase the elimination of carbon in twenty-fours by about one-third over the amount in the same time during rest. It is highly probable that this large formation of carbonic acid takes place chiefly in the muscles. But the quantity of carbon excreted is so great, and in such excess over the nitrogen, that it cannot be accounted for by the destruction of the proper substance of muscular tissue only. Either fat or some other non-nitrogenous body rich in carbon which is present in the muscles must be consumed by their action.

Certain rules follow on this fact. During exercise, the action of the lungs should be thoroughly free. No impediment should be offered to the full play of the chest by dress or any other means. And it is obvious that the increase of loss demands an increase of supply in the form of proper food and fresh air.

Again, as every one knows, active exercise increases the force and frequency of the heart's action; but it should be observed that such excitement is followed by a period of corresponding depression. The character of the heart's action is perhaps the best, certainly the most readily applied, test of the effect of exercise. Increase of force and frequency of the beats is necessary and natural, and while the heart acts regularly and equably there is no sign of harm. But irregularity or inequality of action means over-taxation; and on any evidence of this, such exercise should be discontinued.

Every one knows, too, that exercise promotes the action of the skin. The surface becomes reddened from turgescence of the vessels, and perspiration is greatly increased. Water, as we have seen, escapes from the body by the kidneys, skin, and lungs. During rest far more is lost by the former than by the two latter means together. But during exercise not only is the total amount very largely increased, but the proportion in which it passes off by the different channels is reversed. More now passes off by the skin and lungs together than by the kidneys.

The evaporation of this water, then, from the surface reduces and regulates the temperature, which otherwise, owing to the increase of combustion, would become excessive. Hence the danger of chill from this cause is not during the period of active exercise, for the rapid loss is then compensated by extraordinary supply, but the risk arises when exertion is over. The excessive loss by evaporation still for awhile continues, and now not only is there no additional supply, but a period of slight and temporary depression succeeds the excitement. Hence, the heat of the body rapidly declines. The surface, which may have been exposed with impunity while exertion was continued, must now be adequately covered to protect it from undue loss.

Sir Thomas Watson puts this very prettily. He says: "By attending to the principles now laid down, you will be enabled to furnish those whom it may be your business to advise with many useful suggestions, and to caution them against common mistakes; mistakes which have had their origin in the unqualified credit given to the maxim, that sudden vicissitudes of external temperature, and exposure to cold while the body is hot, are dangerous; whereas, these things are dangerous under certain circumstances only. Thus, you may tell the sportsmen that wet feet or a wet skin need cause him no apprehension, so that he continues in active exercise, and changes his clothes, and avoids all further application of cold, as soon as his exercise ends. You may admonish the bather that after walking on a hot day to the river's side, he had better *not* wait to cool himself a little before he plunges into the stream; and in like manner you may venture to counsel the young lady who has heated herself with dancing, not to linger in the entrance-hall till the glow has somewhat subsided, but to make the best of her way to her carriage, and thence to her bed; and you may tell your male friends who happen to be similarly circumstanced that the best thing they can do is to walk briskly home in their great-coats. The main points to be remembered are that the heat which is preternaturally accumulated by exercise is held with little tenacity, is dissipated by profuse perspiration, and is speedily lost when to this perspiration is added a state of rest after fatigue; and that, in these circumstances, the application of cold is most apt to be prejudicial."

In connection with this excessive perspiration, it is probable that the muscles lose water during exercise. For when water is taken to allay the thirst after exertion, it does not pass off as usual by the kidneys or the skin, and it produces no apparent effect, although the quantity taken is sometimes more than sufficient to compensate the loss of weight due to exercise. It has been rendered highly probable that much of this water passes into the substance of muscle.

It is not practicable to determine the actual amount of exercise which, in order to maintain the health, should be taken by a healthy adult person, for of course there are many circumstances, such as the constitution and habits of life in other respects, varying widely in different cases, to be taken into consideration; but there are some facts which may assist us in attempting to answer the question.

The Reverend Professor Haughton has calculated that walking on a level surface is equivalent to raising $\frac{1}{20}$th part of the weight of the body through the distance walked. It is easy to change this formula into one showing the weight raised one foot. "Using this," says Professor Parkes, "and assuming a man to weigh, with his clothes, 150 lbs., it would follow that walking one mile would be equal to lifting 17·67 tons one foot." "Looking at this result," he continues, "considering that the most healthy life is that of a man engaged in manual labour in the free air, and that the daily work will probably average from 250 to 350 tons lifted one foot, we can perhaps say, as an approximative, that every healthy man ought, if possible, to take a daily amount of exercise in some way which shall not be less than 150 tons lifted one foot. This amount is equivalent to a walk of about nine miles; but then, as there is much exertion taken in the ordinary business of life, this amount may be in many cases reduced."

Athletic exercises have always been in favour with nations distinguished by military success, and so far as robust health and physical vigour are concerned the means fully answer to the end. By a well-devised system of gymnastics, the most thorough exercise of every set of muscles in the body may be secured. And such education of the muscles will imply not only increase of actual strength, but greater rapidity and versatility of action; more adroitness of movement; more skill in the combination of forces. The chief evil of gymnastics, even in relation to their end, is that they are apt to be excessive while they last, and so may not only frustrate their chief purpose, but produce positive mischief; and that when not duly sustained and persevered in, they are likely to be succeeded by periods of idleness in which any temporary good that may have been accomplished is altogether undone.

The amount of exercise necessary for fair health is far short of that which may be accomplished within the limits of health. Hence, many pursuits which vary widely in the degree of exertion they entail, nevertheless fulfil the condition of healthy exercise. And if a man's ordinary occupation secures an adequate amount, he need not waste time by troubling himself any further with the matter. But while, no doubt, too much time is often wasted in this way, sedentary habits and occupation which keep a man much within doors will cost in taxation on the health more than most men can afford to pay. For not only is there much reduction of physical strength, which may be a small matter, but imperfect tissue changes, and the undue accumulation of their products too often lead to disturbances of a grave kind, and interfere not merely with the enjoyment, but also with the usefulness, of life. The temper becomes spoiled, and the irritability which supersedes cheerfulness very often tells of too much uric acid in the system.

The mode of life, or what is more popularly understood as the habit of an individual, has great influence on the health and duration of life. No doubt the commonest and largest error in this respect is in the want of due and proper adjustment of exercise and rest. The maintenance of a healthy proportion between exercise and rest is, no doubt, the exception to the rule. Exercise is a necessary condition of health, and the best form of it is to be found in some useful and congenial occupation. So far as its influence for good upon the whole individual is concerned, it should be of such nature as to engage, in fair proportion, all the bodily and mental functions and faculties. Now, exercise or occupation, or work, is sometimes excessive; it involves too much of wear and tear, and allows only of inadequate periods for restoration and renewal. Sometimes, and more frequently it is not in proportion to the various needs of the system. The mind may be unduly taxed, while the body gets nothing like proper exercise. More commonly, perhaps, the mind is allowed to lie fallow while muscular labour is overdone. One is familiar with instances where, after a day of great mental exertion and fatigue, the muscles are still uncomfortably irritable from want of exercise; but one is far more familiar with cases in which, with daily fatigue from muscular exhaustion, the mental faculties gradually grow very rusty from want of use. Hence, the "proverbial stupidity of the athlete."

It is significant that in its ordinary use the term "exercise" is supposed to refer only to the system of voluntary muscles. But cultivation by exercise in one direction may be, and often is, at the expense of it in another. No doubt muscular exertion involves important consequences beyond those to the muscles themselves, such as its influence on the formation and destruction of the blood, as shown in its effect on the circulation, respiration, and appetite; but, withal, the nobler part—the brain and its functions, the mental faculties—may suffer terribly from want of use. *Mens sana in corpore sano* has become too apt an excuse for the cultivation of muscle at the expense of mind.

But, while it is not difficult to find instances of total excess, and easy to find cases of partial excess, the great evil is far more frequent and pressing in the opposite direction; in the want of adequate and healthy exercise of both body and mind. Where one person suffers from excessive manual or mental labour, many suffer from idleness. To some, at first sight, this may seem to be an exaggerated estimate of the evils of indolence, and, of course, it is impracticable to obtain exact facts for the calculation. There is a wide difference in the form of idleness of different classes; and it is, of course, very important to distinguish between the simple absence of occupation and vicious indulgences. Amongst what are called the labouring classes, it is very seldom indeed that the health can suffer from lack of bodily exercise. The size and condition of the muscles, and the manual strength of the labouring man, tell plainly enough of the beneficial effect of regular action on the strength and vigour of an organ. But here, especially in rural districts, the mental faculties are too often allowed to degenerate by disuse. In too many cases, the want of appropriate exercise is shown in the slowness and difficulty with which they work. In those whose social state absolves them from the need of manual labour in order to obtain what is necessary to life, too often both mind and body suffer from want of exercise; but more frequently the mind than the body. If, by sufficient exercise for health is to be understood that amount of it which enables the mind and body to escape positive mischief or obvious defect, the want of it is still not unfrequently witnessed; but, if by adequate exercise be understood such use as will raise the functions and faculties to their highest degree of efficiency, then indeed it must be allowed to be very exceptional in its effects.

The phrase "practice makes perfect" is on the lips of every one, yet perhaps very few appreciate the fact. Extraordinary feats of body and mind are presented to our notice, and, whatever original endowments may be involved in the performance, such endowments, without sedulous cultivation, could never have approached such results. But, short of feats that startle us, every one by practice, it need hardly be said, learns to do what he could not do before; and not only this, but far more commonly learns to do better what he did before; learns to work up to any given result more easily, with less effort, and therefore with less fatigue. This should be understood. The sense of fatigue or exhaustion is by no means always in proportion to the amount of actual work, whether in quantity or quality. Even with persons of equal natural endowments, practice makes this great difference: it renders any kind of given work less arduous. What is done habitually is done at less cost; so by practice expense is saved.

This may be put in another way. We grow tired soonest of that kind of work which requires the greatest effort of the will for its performance. In proportion as it can be done without conscious effort, it can be done upon easier terms. There is certainly a very direct relation between the activity of the will and consequent exhaustion. This in the relation of the will to muscular action is very obvious. In trying to execute certain movements which involve a complex combination of muscles—as, for instance, in learning to play on the piano or violin—so long as these actions are strange and difficult, so long as they require a constant effort of the will or direction of the attention, so long we soon become tired and the muscles ache; but as by practice we learn to use and combine the muscles in a certain way with greater facility, so do we become able to employ them for a longer period without exhaustion. This improvement may be partially due to greater strength in the muscles themselves from exercise, but that this is not the chief factor in the result is proved by more than one fact. The same muscles are not found equally capable of sustained labour in any other direction. When the accomplishment of playing is once attained, it may be laid aside for years and then resumed with far less sense of fatigue than at first. In endurance, the strong muscles of an untaught hand will have no chance against the delicate ones of a skilful musician.

But this effect of the exertion of the will on the sense of fatigue has far larger issues. Certain movements are habitually performed without the intervention of the will, or even of consciousness, but which, nevertheless, may involve consciousness, and may be, within limits, controlled by the will, as the movements of respiration. From the period of birth they are of this character. But there are other kinds of movement which, although not of this character at the outset, gradually acquire it by practice or habit in the course of time: such are the movements involved in walking. A child has to learn how to walk; at first, considerable effort is engaged in the attempt; the attention must be constantly given to the act; the will must be active to direct and control. But in the course of time, the combination or co-ordination of particular muscles to a definite purpose becomes easier. They fall into their proper action with less effort; the will needs not to be so much on the alert. By and bye, the attention may be withdrawn from the act altogether, and otherwise engaged without any interruption to it. Then it is no longer, strictly speaking, voluntary; and the consequent sense of fatigue is removed backward to an infinitely greater distance. This becomes a striking illustration of the force of habit, and of the truth that use is second nature. The movements involved in the practice of playing on a musical instrument, as in the instances already referred to, belong to the same class. A skilful performer may play very correctly and brilliantly on the piano, and yet during the whole period may carry on an animated and absorbing conversation. It is sometimes said, and, probably, the expression is not very wide of the mark, that in such a case the performer plays instinctively. The relation of habit to instinct is a curious and suggestive one. What are called confirmed habits appear to be very closely allied to acts which are purely instinctive. In acts properly instinctive, there is the obvious adaptation of means to ends, but without the necessary intervention of ideas or of any effort of the will. Acts of this kind, nevertheless, vary widely in the degree to which these conditions are fulfilled, and in other ways. Some are very purely instinctive from the first, and from these, through others, we may pass without any abrupt transition to confirmed habits. And in this view it is a reasonable conception that instinctive acts may have arisen out of confirmed habits, transmitted through many generations.

And, furthermore, it may be remarked that what is true of the will, in relation to muscular action, is true of it also in relation to the intellectual powers. Man is distinguished from the highest animals not only by the superiority of his intelligence, but also by the power of his will over his intellectual faculties. In man, no doubt, the will, in this relation, is singularly dominant; but among men there is a very wide difference in the degree to which it is supreme. The quantity and quality of intellectual work which is done is largely due to the degree of development of the intellectual faculties; but it is also largely due, no doubt, to strength of will. The power of forcing one's self to work at a particular time, or at a particular subject, in spite of powerful temptations to other pursuits—

the power of abstraction and of concentration of thought in spite of disturbing influences from without—may be taken in illustration of the power of the will in governing the operations of the mind. But here, again, the effort involves fatigue. Who does not understand this? Work which is done heartily is done very easily: when we work because we cannot help it we know no exhaustion. But how soon do we grow tired of work which is not agreeable, which we do only under sheer compulsion of the will! And as the sense of effort is very closely linked with the sense of exhaustion, such work is very seldom a man's best or highest. Yet in this case also the force of habit is very great. No doubt in certain directions very much of the best and highest work is done under impulse, at irregular times, and in irregular ways. In the field of the imagination, perhaps, very much work is thus produced. Yet even here there is much of exaggeration and self-deception. But in work which involves a larger combination of intellectual powers, the importance of previous training by practice, of mental discipline, is paramount. Place a subtle question of logic before two minds; one, originally and otherwise the more powerful, but unaccustomed to such work, untrained in exact methods of thought; the other of inferior calibre, and yet in the habit of close reasoning. How can the difference of result be explained? This question lies, or rather ought to lie, at the root of all systems of education. In every kind of education, properly so called, the acquisition of knowledge is a great purpose; but a far greater purpose lies in development and training; in drilling for combined and concentrated action; in a word, for skilful use.

Thus, then, by habit, work is made easier. By practice, the sense of effort is gradually lost, and consequently the sense of fatigue; so that, by this means, it comes to pass that, within the range of healthy exercise, more work can be done. In what is skilled labour, this has to be considered. The work is not only better done, but in any given time much more of it can be done. To the questions—How much work ought to be done?—how little will suffice for the purpose of healthy exercise?—it is, of course, from the very nature of the case, impossible to give a precise answer. A great deal must depend on the effect of exercise in any particular case; on the natural strength and power of endurance—on energy; and a great deal must depend also on the rate of repair during the period of rest. There is much difference between individuals in this respect, and this is marked most plainly in the amount of sleep which is required. This by no means corresponds with the amount taken, which is usually far in excess of what is actually needed. Here again, too, habit comes powerfully into play. In fact, it would be difficult to find a more signal instance of the force of habit than in the portion of time passed by different individuals in sleep. The need here is largely regulated by habit. But, putting this consideration aside, the amount of sleep naturally required varies widely in different persons. This is due, in part, to the varying degrees of activity of the vital changes. Thus, although these are most active in the young, the young require much sleep, because the rapid rate of repair during that period is met by the rapid rate of waste during the day. Both by day and night the changes are then most active. The aged also require much sleep, because, although there is comparatively little waste during the day, the process of repair is slow too. At both extremes of life, long periods of sleep are required, but on opposite conditions. For, observe the difference here in the intensity of sleep. Compare the light and often broken slumbers of the aged with the deep, long sleep throughout the night of the child. Mark, too, the further contrast. Deep as the sleep of childhood is, the vital functions are still very active, and the sustained vigour of the heart is shown in the ruddy lips and glowing cheeks. In the aged, with lighter sleep, the flagging circulation is obvious in the pallid and shrunken features. The contrast drawn by Shelley, in the opening stanza of *Queen Mab*, between the aspect of sleep and death, is true only of childhood. As a rule, it may be said that the duration of sleep should be inversely as its depth. Those who sleep most soundly get most good out of it in any given time, and in this way it may be viewed as the correlative of exercise. Light sleep corresponds to languid exercise, sound sleep to vigorous exertion. But here, as elsewhere, bad habits come into play. Sleep is often broken and unsatisfactory because it is excessive. When the natural wants of the system have been supplied, and sleep is still sought, it fails, and restlessness and discomfort are apt to supervene. This relation of sleep to fatigue, of repair to waste, is shown in the different degrees of sleep in the first and last hours of it. Persons in health, and free from influences which oppose rest, as a rule, sleep most soundly at first, and still sleep perfectly through the night, but towards morning the sleep becomes slighter. They are most easily awakened, and, if roused, may find it difficult or impossible to fall asleep again. This means that the want expressed by sleep under natural and healthy conditions is supplied.

Much information of an important kind is to be derived from a knowledge of the habit of a man in respect to sleep. The popular view which connects sound sleep and a good appetite with health is founded on established principles of physiology. It means not only that the supply is equal to the demand, but that the demand is sufficient for the prosperity of the body. It means that consumption has been sufficiently active, and that there is also the material and process of renewal. As a rule, no doubt, the largest amount of the best work in life is done by those who can sleep well. Nor to a healthy man is any amount of work, perhaps, injurious which is followed by a due amount of sound sleep. Some confusion prevails here. Mental labour and the wear and tear of mind are too often put together. Steady, hard work, which engages in tolerably fair proportion the mental faculties, is one thing ; the effect of worry and anxiety, in their manifold forms, is quite another. No doubt, the two conditions are very often combined, and in actual life must necessarily be so ; but, nevertheless, their influence, in its bearing on life and health, must be distinguished. So long as the work which a man does is congenial to him and fairly successful in its result, or so long as it is not overburthened with care and anxiety, interfering with his repose and appetite, it can scarcely, perhaps, in a physiological sense, be too hard for him. And herein lies a good practical test of the matter. Enquire into a man's habits, the time devoted to and the nature of his work ; but enquire also further into his ways. Is his appetite good and are his wants properly supplied ? Does he sleep well ? When he goes to bed, has he any difficulty in falling asleep ? Does he awake refreshed in the morning ? Or is he tormented on his pillow by the events of the day ? Is he still unable to cast aside the cares of business ? Does he habitually dream of them ? It is reported of one of our most eminent lawyers and busiest men, who reached the highest place in his profession, and died at upwards of ninety years of age, that he was wont to declare he owed all his success in life to being able always, no matter what the stress of business might be, to go to sleep as soon as he placed his head upon his pillow. This was only saying in another way that he was not hurt by hard work, and that those treacherous enemies of health, the cares and anxieties of life, were kept aloof from him. Here, of course, the important question of temperament comes in. An event which will destroy the sleep and appetite of one man for a week will have no sensible effect for a moment on another. But this is a further argument in favour of the distinction which should be drawn. Different temperaments are not so differently affected by hard work, in the proper acceptation of the term, as by care, anxiety, worry, and the like. In fact, for such people hard work is often in the long run the best remedy.

It is not, perhaps, difficult to understand the beneficial influence of change or of variety of occupation in the case of those who are engaged in regular hard work; but much will depend on the nature of the work which is habitual. The more congenial this is to the taste and inclination, the more fairly it engages, either simultaneously or in succession, the several faculties, so does it fulfil all the conditions of healthy exercise; but in proportion as its sphere is narrowed and it is monotonous, so does it require to be supplemented by other forms of action. This is needed even for the organs which are habitually exercised, because for them some variety of action will add to their vigour; but it is needed far more for others, the exercise of which is partially or totally neglected. This may be illustrated in a broad way by the influence of sedentary pursuits. Clerks, for instance, who are confined all day to the desk, need some special arrangement for active exercise. Those who sit during many hours working with their hands and arms, need also exercise for the muscles of the lower limbs. Those whose brains are exercised all day over figures and accounts, need, in conversation or literature, the exercise of the imagination. Nature herself is wont to speak very plainly on this subject. No doubt, the cry for change is too often an exclamation of idleness, but it is often also the natural expression of weariness of some structures and of restlessness of others. The universal agreement to banish "shop" as a topic of conversation in leisure hours means the same thing.

But with all this, it must never be forgotten that a state of typical health, and a capacity for the best kind of work, are not quite one and the same. As a rule, the best state of health is the best condition for work, and a perfect state of health is that in which all the functions are in vigour. But, practically speaking, when can this be? Even in the case of a man not pressed by necessity, and altogether master of his actions and mode of life, much of the pleasure and far more of the purpose of existence would be lost by too rigid an attention to the laws of health. Nay, this very attention would become an obstruction to their fulfilment. A man whose prime purpose in living was the preservation of his health would be but on a level with the miser who can see no purpose in money beyond hoarding it. But the great majority of men have to work of necessity to earn a livelihood, and this of course involves, in every case, doing many things in which health is not the prime consideration. Nor is this, in the long run, prejudicial to a man's capacity for work; but, on the contrary, it promotes it. For what may be lost of full vigour in one direction is more than compensated in another, and that the one wherein strength is most needful. Particular forms of manual labour develop particular groups of muscles, and these become excessively large in proportion to others; but by this means, a man's capacity for his work is increased. So with mental labour. In neither the poet nor the mathematician is there a due and equal exercise of all the faculties; but in both cases, the highest results are reached by the preponderance of some faculties over others. And thus, while freely acknowledging the force of the maxim, that a healthy mind must be the outcome of a healthy body—understanding here by the term health the most efficient state for action of all the faculties—we can have no difficulty in comprehending how the noblest and highest achievements of the intellect have been reached by those who have been heavily burthened by bodily infirmities; aye, and by mental ones too. A feeble cripple has written immortal verse, and half the world has been conquered by a man who was sometimes weaker than a child.

The duration of life, and the state of health, are oftentimes materially affected by accidental disturbances; by injuries and diseases which, although in their nature temporary, leave, nevertheless, in the system permanent effects. Such effects may be revealed in various ways: a severe injury may be recovered from, or a serious illness may pass away, and yet leave the system in a state of exhaustion which is, in some degree, permanent; from which, during the remaining portion of life, it never has sufficient power to recover. The power in reserve—the power of repair—is not fully equal to the task. It is said of such a one that he has never quite recovered from the shock of the accident or of his illness. This is most frequently seen in those advanced in life. As a rule, and for reasons already discussed, the prospect of recovery in this sense diminishes with age. But there is another way in which the effect of illness or accident becomes subsequently revealed, and in this case in the young as often as, or more often than, in the aged. Some important organ may be irreparably damaged; but still damaged in such a way that for a long while afterwards it may continue to do its work, and to do it so well that, perhaps, for years no attention is directed to the flaw. And yet at length, in the course of time, the defect tells. The work can now be adequately carried out only under favourable circumstances. When extra exertion is called for, the organ begins to fail. Then, for failure implies the need of better work to compensate which cannot be performed, the mischief rapidly increases, and soon proves fatal. An illustration of this has been already given in the instance of the heart.

No doubt much harm is often done to health, and life is sometimes considerably shortened, by continued exposure to various noxious influences; such, for example, as the substances which, under the vague term of impurities, often find their way into air and water. The effect of air and food themselves in relation to life and health has been already alluded to, but each of these may be, and often is, the vehicle for the introduction into the system of some more or less actively noxious agent. Indeed, we all are beginning to understand now how by these means the poisons of various deadly fevers, and of other grave and oftentimes fatal affections, are introduced into the system. But beyond the invisible particles of organic and living matter which can thus act in a definite manner—the germs of various specific fevers—there must be many other forms of matter which, although they do not produce any sudden and striking mischief, yet, nevertheless, gradually undermine the health and strength. The atmosphere of crowded cities and manufacturing towns is to very many people deleterious in this way. The worst fogs of London, indeed, often go to the length of producing definite disease, as bronchitis in its various forms; and there can be no doubt that it is thus largely concerned in raising the tables of mortality at particular periods of the year. But even short of this, as too many are made conscious, they interfere with health and produce disturbance. The lungs themselves, and the glands connected with them, when examined, often bear witness to the kind of atmosphere in which a person has passed the greater portion of his life. Carbon inhaled for many years in an impalpable form, in spite of the exquisite arrangement in the pulmonary membrane for its rejection and the filtration of the air, finds its way into the tissues, and some portion of it becomes permanently lodged there. Then, emanations of every sort from manufactories and exhalations from the soil; matter in some of its manifold forms beyond the reach of reckoning; the infinitely varied products of natural or artificial changes; these pass into the air or find their way into water, and hence through the lungs or stomach into the system. And for a very large proportion of the population whose lives are, for the most part, passed under other influences of a depressing kind, for those who work and live in confined spaces, want of ventilation means not only the absence of pure air, but the concentration of products, whose mischievous effects are thereby much increased. In truth, in regard to the conditions under which the great bulk of the people live, the wonder is not that so many bear the stamp of feeble health and die before old age, but rather that, notwithstanding this, they can survive so long in the struggle for existence. And to understand it, another factor must be taken into account. During life, the body, as a whole, and the several structures which compose it, possess a power of resistance, so that exposure to noxious agents of various kinds does not always or usually result in the manifestation of disease. In this way must be explained the escape of so many from what must be regarded as very serious risks.

For example, a number of persons may be exposed to the influence of some contagion. That the poison is active for mischief—that is, with a capacity for development—when it alights on a favourable soil, is proved by the fact that one or more of those exposed to it succumb; but that the majority are able to resist it is shown by their escape. Of course, in such a case it may often be that the different result is to be attributed to the different doses of the poisons received; but the contrast can by no means be always thus explained. In fact, we all know that, while some will readily succumb to slight exposure, others will obstinately resist the repeated introduction of comparatively large doses. To what this unequal power of resistance may be due is a question beyond the reach of our present knowledge. Some light may be thrown on this obscure subject by the familiar fact that in the case of certain diseases thus contracted, such as measles, scarlatina, and small-pox, one attack, as a rule, prevents a second; it produces some change in the system or blood by which it is rendered proof against any further operation of the poison. But many persons not thus guarded resist throughout life frequent exposure to these diseases; and many more, after repeatedly escaping serious risks, at length succumb. One fact of high practical importance is tolerably clear: the more thorough the health—the greater the vigour of the body—the less chance have poisons thereon. Whatever reduces the strength diminishes the power of resistance. Thus, these noxious agents appear to have the best chance of working mischief during periods of depression, however produced; during sleep, for instance, and after prolonged fasting. Yet, for certain of these poisons, at all events, the influence of robust health and vigour is largely qualified by other considerations, conspicuously by that of age. Every one is aware that the liability to catch certain complaints is diminished as life advances.

Now, the nature of the various forms of matter which find their way through air and water into the body, and work evil there, must be very different. Some belong to the inorganic and some to the organic world. Of organic particles, some are dead—the outcome of death and decomposition; some are living germs or seeds, apt for development when sown in a suitable soil. Whether vegetable or animal we know not; probably neither—being the simplest forms of life, and not as yet possessing qualities characteristic of either kingdom, but endowed, and this is their most significant attribute, with a stupendous power of multiplication. From a knowledge of this great fact, and from analogy drawn from the results of genesis elsewhere, it is concluded that in the case of living germs the effects of the poison cannot vary with the dose of it as in the case of inorganic substances. The effect of arsenic or prussic acid on the system can be accurately regulated by the quantity administered; but in striking contrast to this it is believed that in regard to ultimate result, owing to their power of propagation, the introduction of a few germs, or even of a single one, will be as injurious as the introduction of a whole colony. And this, in some instances, may be true. But, nevertheless, such a doctrine needs to be accepted with reserve. If it were true without qualification, how shall we explain the fact that so many escape from all kinds of mischief in the midst of an atmosphere laden, as ours must be, with poisonous particles? If we reflect for a moment on the manifold sources of contagion, we must believe that the poison however diluted, that the germs however scattered, must, some of them, be practically everywhere; and even if we suppose, as many do, that these differ widely in their nature and properties and that the great majority are harmless, still even then it is difficult to understand how we daily can escape the influence of those which in their nature are most deadly. Nay, furthermore, the fact that transient contact with the sick who are suffering from infectious disease involves, as a rule, infinitely less risk than prolonged exposure, is not striking enough only because it is too familiar. Therefore, whatever difficulty in the present very imperfect state of our knowledge may be found in the explanation of it, the fact remains that there is strong evidence to show that the degree of mischief wrought by germs is sometimes determined by the number which gain access.

It may be, however, that a streak of light appears even on this dark subject. The direct action of germs upon living structures can be studied in the case of wounds, and here the resistance which is offered to their action during life and health is very obvious. When these organisms fall on dead animal matter they completely change it. During their growth and development, it is decomposed and rapidly converted into a putrid mass; but on living, healthy tissues they usually fail to produce any such effect. Vast numbers of them may be injected into the midst of the tissues without any evidence whatever of evil result. But under certain conditions in the case of wounds, when the vital power of the tissue is enfeebled, they gain the mastery and so may beget fatal mischief. No doubt their action, in its degree and scope, is modified by other causes. Very much must depend on other conditions under which they operate, but the fact just mentioned is the significant one in relation to the present question—that structures in a state of health and vigour are enabled to resist certain septic influences to which others which are dead or enfeebled will succumb.

But the power of resistance or of recovery is constantly shown in another way. We are, all of us, habitually doing many things, living under various conditions, not altogether good for us; yet, at least through a long series of years, if we do not trespass beyond certain limits, no apparent harm comes of it. And this should form part of the answer to be given to the very frequent enquiry whether this or that thing is wholesome or injurious. Many of these things are not strictly beneficial, but the contrary; and yet in moderation they may be indulged in, because during life there is a power in reserve which enables us to cope with these comparatively insignificant effects, and to overcome them again and again without, for the most part, any permanent injury. Take the instance of alcohol. It is difficult to show that there is any advantage whatever in its habitual use by a healthy man, and yet it is equally difficult in most instances to demonstrate any evil effect from moderate indulgence in it through a lifetime. Or take the instance of tobacco. It is idle to contend that smoking is in any sense beneficial to the large majority, and yet again very many smoke all their lives and appear to be none the worse for it. That the influence of these habits is rather injurious than otherwise to most men is suggested by the fact that when an effect appears at all it is usually on the side of evil. But the explanation of the impunity with which these and other practices are indulged in is probably to be found in the fact that in most of us there is a power in reserve—analogous, perhaps, to that of repair in the case of wound or injury—by which mischief is in great degree resisted or overcome. Yet, withal, it must be borne in mind that various habits may work much evil in the long run without the relation of cause to effect becoming at any time apparent. As we have already seen, very few, if any, persons die, strictly speaking, of old age. Almost all, in the proper sense of the word, die prematurely; from some particular weakness or defect before the structures in general are quite worn out. This must mean, at least in a large proportion, exposure to conditions not favourable to health.

No one who pays any attention to this subject, who will be at the pains to study the laws of life and the conditions under which health is maintained, can fail to see that the vast difference which exists between what actually is and what might be depends not so much on want of knowledge as on want of action. Ignorance, no doubt, has much to do with sickly lives and early deaths, but surely the indisposition and want of will to act on what is clearly understood has much more to do with the presence of disease and premature decay. As an instance of this, let us refer for a moment to the influence of intoxicating liquors on the population. Is the absence of any effort to control or mitigate the evil due to any doubt of its effect on life and health? Has not the potency of alcohol as an active agent of various diseases, as the chief cause of that condition of body and mind in which both will easily succumb to trivial forms of mischief, been established beyond all question? And then is it exaggeration to say that, if the abuse of alcohol were unknown, half the sin and three-fourths of the poverty and misery of the world would disappear from it? Or, for another illustration, let us recur to the subject of infection. Do we avail ourselves of what is clearly known, and even generally recognised, of the laws which regulate the propagation of infectious diseases? Are we still waiting for the necessary knowledge? When will the time for action come?

For the man himself, then, who has the resolution to act according to knowledge, it will not be very difficult to understand, or impracticable to obey, the chief laws by which health and energy may be preserved. These have a twofold aspect. They relate to the individual himself; to his habits and mode of life. They refer to the external conditions under which he lives; and they have regard to his social relations. In the first case, the circumstances are usually more within his control than in the second, and fortunately so, for the effects of external conditions will be always largely influenced by personal habits. It is often hard to obtain many things that are desirable; it is often easy to avoid many things that are injurious. In one direction the sole, in the other the chief, danger lies in excess. The wisest counsel was long ago set forth by Plato and by St. Paul in their exhortation to temperance.

But if, after all, it is still asked to what end is a long life and the maintenance of health, the trite answer must be given that life and health are only opportunity. The value of life and the importance of health must, of course, be measured by what a man is thereby enabled to do. And thus it is that, in the long run, neither the one nor the other may be of the first consideration. It may be best, or even necessary, to sacrifice one or both. In this way beyond any other they may be well spent, provided only that the sacrifice is always a worthy one.

Man's Place in Nature.—Finally, let us for a moment consider the question of man's place in nature.

In nature all objects may be divided into two great kingdoms; one consisting of those which neither are living nor have ever lived, the other consisting of those which either are living or have lived. The former is called the Mineral Kingdom; the latter includes all Plants and Animals. The Animal Kingdom is again divided into groups according to the complexity of the structure and the arrangement of the organs of its members. First of all, into those which possess an internal skeleton—the vertebrate animals; and those which do not—the invertebrate animals. To the latter belong corals, worms, insects, shell-fish, snails, cuttle-fish, and the like; the former consist of the classes of fishes, reptiles, birds, and mammalia.

All zoologists are agreed that man's place in nature is at the head of the class of mammalia, and that, in anatomical structure and plan of formation, he is very closely related to the highest animals. Zoologists, however, are not altogether agreed as to the precise mode in which that relationship should be expressed. Linnæus places man and the apes in one order, called Primates, with lemurs and bats. Blumenbach, followed by Cuvier, recognised in the genus Homo characters sufficiently distinctive to enable man to rank as a separate order. To this was given the name of Bimana (having two hands), in contrast to apes and monkeys, called Quadrumana (possessing four nearly similar handlike extremities). And while Owen, on the one hand, has gone still further in this direction, separating man more widely from the animals nearest to him, on the ground of the comparatively great development of his brain and psychical powers, Huxley, on the other, has argued that the anatomical difference between man and the highest of the quadrumana is less than the difference between the extreme types of the quadrumanous order.

It must be evident to those who have examined it that the view which has been taken of the relation of man to the animals around him has been largely influenced by the stand-point from which the question is regarded. Those who have studied the subject from an anatomical and physiological point of view—in short, as a question of natural history—find a very close relationship indeed between man and the highest animals ; while others, who have pursued the enquiry from an opposite direction, discover in man's moral nature and destiny so vast a chasm between him and every other living creature that they can see no force in any facts or arguments which would in any wise bring them together. But surely, if confusion is to be avoided, these views must be kept apart. The natural history of man is one thing ; his spiritual life is another. We may accept without reserve the highest claims advanced for man in his relation to another world, and yet in his physical structures and functions find no difference whatever, save in degree, between him and the animals nearest to him. In bone, muscle, and nerve he is made in the same way ; constructed upon the same plan. In fact, during the earliest weeks of his formation, the most minute scrutiny fails to discover any difference whatever between him and other animals. Indeed, it would be well for those who are so soon offended by any comparison of man and animals to consider more thoughtfully this part of the subject. Such differences as may afterwards be found between man and the highest animals, as the greater degree of development of his brain and the perfection of his hand as the instrument of his mind, have no place in the earlier periods of his existence. Nay, first of all he is on a level only with the lowest forms of life. The substance out of which he is formed is in no way distinguishable from theirs. In the course of his embryological development, man passes through stages which correspond to those of the lower animals. Whatever objections of a moral nature can be urged against the doctrine of evolution must, it is at once seen, apply, with equal force, to the mode of man's development. If it be asked, supposing man to have been evolved from some inferior form of life, how it happens that he became possessed of his present attributes, it may be fairly asked, in rejoinder, when in the course of his existence does he first become possessed of them? It would seem hardly worth while to object to the doctrine of the evolution of the human race from some lower form when the fact is before us that every man in the first instance is nothing more than a minute morsel of yelk. No; these questions must be kept apart. Man has a past history and a future life beyond the grave. His mortal nature is one thing; his immortal nature is another; and the origin of his body cannot determine the hereafter of his soul. Even in his present state he is distinguished from all other living creatures by the development of his moral faculties, by his knowledge of good and evil, of the law of right and wrong; but this has no bearing on the facts of his anatomy and physiology; and it is in vain to deny that such high attributes can belong to a being who, in structure and function, has so close an affinity to the brutes. St. Paul had no doubt of man's resurrection and of the immortality of his soul, yet he spoke of the body as "of our humiliation," and declared that it shall be changed.

FOOD AND ITS USE IN HEALTH.

By Sir Risdon Bennett, M.D., F.R.S.,

Late President of the Royal College of Physicians, London.

Nature and Requirements of Food—Alimentary Principles—Sources and Varieties of Food—Alimentary Substances—Animal Food—Vegetable Food—Fruits—Farinaceous Foods—Saccharine Substances—Water—Tea—Coffee—Cocoa—Condiments—Preparation of Food—Preservation and Employment of Food—Proportions of Different Kinds of Food—Supply of Liquids—Diets of Various Peoples—Deficiencies in Food—Times and Frequency of Meals—Diets of Different Ages of Life.

Nature and Requirements of Food.

What is Food? To this question we must be able to give a correct and definite reply, in order to understand how best to employ food for our well-being and comfort. A very simple answer would be, all that contributes to the maintenance of the organisation of our bodies in life and health. This, however, would be a very insufficient, as well as, in some respects, a too comprehensive, answer. It is evident that we must know something of the constitution of our body, and the nature of the requirements needed to maintain its life and actions, and whether the substances which we call food meet these requirements, to what extent, and in what way. We must ascertain, in the first place, of what elements the body is composed, in order to learn what is needed to maintain its organisation. We should know something of the modes in which these elements are disposed of, what becomes of them, and how it is that they constantly need replenishing. And thus an essay on food must either assume a knowledge on the part of the reader of the constitution and functions of the body and its several parts and organs, which only a physiologist can be expected to possess, or we must endeavour to give a brief and simple account, intelligible to the general reader, of what is implied by nutrition and growth.

Man, like all other animals, must be supplied for the purpose of his nourishment with organic substances previously formed either by animals or vegetables. He can modify or transform these compounds, and render them fit for the special purposes of his own body, but he cannot originate them from the mineral or inorganic kingdom. Vegetables alone can form organic compounds from the inorganic kingdom. All our food, therefore, comes in the first instance from the vegetable kingdom, either directly or indirectly, through other animals. Vegetable-feeding animals, such as the cow and the sheep, go directly to the vegetable kingdom for their food, whilst the carnivorous animals, such as the lion or the tiger, live on organic compounds already produced for them from the vegetable kingdom by other animals. Man, who is called an omnivorous animal, can appropriate both species of organic compounds.

The principal elementary constituents which are appropriated by vegetables, in order to build up the various organic compounds which they originate, are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potash, and lime; and of these carbon is by far the most extensively used. There are other mineral substances, some of considerable importance, as soda, which enter into the composition of the compound materials of which our bodies are formed, but those elements enumerated must be viewed as the most essential.

We know pretty well the sources whence plants derive these elementary substances, but how they are separated and combined the one with another, and how from the more simple organic compounds thus formed, others of a more complex constitution are produced, to be again disintegrated and made to perform their various offices in the vital processes of nutrition and growth, are much more difficult problems to solve, respecting which our knowledge is as yet very imperfect. We know, indeed, that for such wondrous functions life is essential. But what is life? It is quite true that many of the processes carried on by living organisms are explicable by chemical and physical laws, but how these laws are controlled and made subservient to the purposes of life we know not. All living structures with which we are acquainted are derived from previous living organisms. Dead matter cannot originate living matter, though living matter can appropriate and give life to dead matter. Some of the lowest forms of vegetable life consist of but a few elementary substances, which they can obtain from the atmosphere, such as carbon, nitrogen, oxygen, and hydrogen. Others, whose organisation is more complex, require other elements, which they derive from the soil, and without which they perish. By the decay and decomposition of these, fresh soil is prepared for the nourishment of higher and higher forms of organic life, by which, at length, those compounds are formed which contain all the elements requisite for the support of animal life.

Alimentary Principles.

The organic products formed by the action of vegetable life when classified according to their composition are termed "alimentary principles," all of which, either singly or conjointly, enter into the composition of our various articles of food, or "alimentary substances," as they are called. These "alimentary principles" are divided, first, into the two primary divisions of "inorganic" and "organic."

Of the first, or "inorganic," it is not necessary to enter on any detailed consideration. It is sufficient to say that there are certain mineral and saline principles which are indispensable for the life of man and the higher animals, such as water, common salt, lime, potash, magnesia, iron, and phosphorus, and some others. These must all in some way or other have a place in those alimentary substances which constitute our food. Phosphate of lime, for example, enters largely into the composition of our bones and other parts of our frame, and water is essential to the performance of various functions and the different chemical changes which the food undergoes in the system. Deprivation of any one of these inorganic or mineral substances is sufficient to induce disease in fatal forms, as in the case of scurvy; hence, if articles of food do not contain them in sufficient quantity, experience teaches us to supply them in a separate form, as when we take salt with various kinds of food. The instinct of animals, in like manner, teaches them to supply their wants in this respect; thus poultry are observed to pick up lime and mortar, as containing elements that are needed for the formation of their egg-shells.

Organic Alimentary Principles.—These, again, are divisible into two grand and distinct groups: those which contain nitrogen, or the "nitrogenous;" and the "non-nitrogenous":—

I. *Nitrogenous Principles.*—Although nitrogen constitutes so large a proportion of the air that we breathe, and though it enters so largely into the composition of the animal frame, we do not obtain it direct from the atmosphere, but from various organic products, of which it is an important constituent. Some of these nitrogenous principles are the products of animal life alone—viz., the gelatinous, the most characteristic property of which is that, on cooling, after being dissolved in water, they form what is called "jelly." The other members of the group are the products of both vegetable and animal life, and are termed the "albuminous," or *proteine* compounds, from possessing an analogous composition to "protein." The principal albuminous compounds are albumen, fibrine, and caseine. The white of egg consists of albumen, which becomes solid by heat, as after boiling; fibrine is that constituent of the blood which makes it coagulate or clot after death, or when withdrawn from the body on becoming cold; whilst caseine is the proteine compound of milk, and constitutes the basis of cheese, whence its name. The vegetable kingdom also affords us analogous principles which have received the same names—viz., vegetable albumen, fibrine, and caseine, the chemical constitution being almost identical. Vegetable albumen is found in wheat and other cereal seeds, and in the juices of many vegetables. Vegetable fibrine is also obtained from the cereals, and forms part of the tenacious mass called gluten, which remains after washing out the bran, flour, and starch, &c. Vegetable caseine is obtained from peas and beans and other leguminous plants, and hence is often called "legumine."

II. *Non-nitrogenous principles* consist of three groups: (*a*) The fats, called by chemists the hydro-carbons. (*b*) Starch, sugar, &c., called carbo-hydrates. These two groups consist of various combinations of oxygen, hydrogen, and carbon; and in the carbo-hydrate group, of starch, &c., the oxygen and hydrogen are in the proportions to form water. (*c*) Alcohol and the vegetable acids.

Both the animal and vegetable kingdoms supply us with fats as articles of food. They all contain, besides their respective peculiar base, a fatty acid, and the fatty matter exists chiefly in the forms of stearine, margarine, and oleine—the first being the most solid, the last liquid, and margarine holding an intermediate position.

The carbo-hydrate or starch group is a much more numerous one, the principal constituents being starch, various kinds of sugar, gums, a substance called dextrine and certain acids, the lactic and acetic acids. Of all these, as an alimentary principle, starch must be looked on as the most important, as it enters very largely into many of our most common articles of food. It is a purely vegetable product. It consists of little grains made up of concentric layers, of which the outermost is of harder texture than the rest. These granules, when subjected to heat by boiling, swell up and burst the outer coating, forming a mucilaginous mass, which on cooling becomes gelatinous. This action of heat is necessary to enable the stomach to act on the starch grains, which otherwise might pass through the alimentary canal undigested. Even animals whose digestive powers enable them to feed on whole grain are found to thrive better when the food is bruised for them, and the starch grains thus in a measure broken up.

Of the sugars, cane-sugar and grape-sugar are products of the vegetable kingdom, and are found widely distributed; but lactos or sugar of milk, and inosite or muscle sugar, are animal products, the milk of mammals being the only source of the former. Alcohol and some of the vegetable acids are considered to hold an intermediate position between the fats and the starch or carbo-hydrate groups. Of alcohol we shall not have to speak specifically in this article.

All alimentary substances constituting our food, being composed of these various principles in various proportions, differ in their relative importance according to the special purposes for which they are needed. These purposes in animals of high and complex organisation, as man, it need scarcely be said, are very various. But there are two distinct purposes or destinations of all foods—the one is the development, or growth of the body and its constant renovation to supply the constant change or disintegration that goes on, and the other is the supply of material for heat and force production, as in respiration and muscular action, during which the amount of material required for those chemical changes by which force is rendered available is very large. In other words, our food has to supply the "matter" of which the body is made up, and "force," by which its various actions are produced and sustained. To describe, on the one hand, the various changes which food undergoes by the processes of digestion, assimilation, secretion and excretion, or on the other the various chemical changes resulting in oxygenation and the production of heat and force, would lead us into most intricate and difficult physiological problems that would be quite out of place in such an article as this. But when speaking of the influence of food on health, it is all important to remember these two distinct purposes for which it is required, whether for the maintenance of animal heat and the production of muscular force, or the mere supply of material substance to uphold the bodily frame. In a steam-engine, the coal, or food, goes entirely to the production of force or power, by which the machine is made to act; it contributes nothing to the maintenance of the machine itself. But in the human body food has to fulfil the twofold purpose of forming and constantly renovating the machine, and also of generating the force by which it is made to work. In the foods prepared by nature for the maintenance of the life of the young of animals, we have these distinct requirements supplied in marvellous combination and perfection. Milk and eggs contain the nitrogenous or tissue-forming principles, the carbo-hydrates or chief force-producing agents, and the mineral, saline or inorganic principles—which are also needed.

Having given this brief account of the various organic products which are necessary to the maintenance of animal life, and which when taken into our system undergo various and often very complex changes in order to be eventually converted into blood, and then again disintegrated and combined and ultimately built up so as to form our bones, muscles, nerves, and other structures, we must now enumerate and examine the more important articles which we use as food, and see how far they are suited for our purpose.

SOURCES AND VARIETIES OF FOOD.

Alimentary substances or food are naturally divisible into animal or vegetable according as they are derived, indirectly or directly, from the vegetable world, which we have seen is in all cases their original source.

The composition of the bodies of the higher animals and of man being identical, it might be supposed that in animal food we have all that is essential for the maintenance of our frame; and such is the case, provided the particular animal food that is selected contains material for heat and force production as well as for the maintenance of the tissues and organs. Thus in eggs, milk, and fat meats we have all that is really essential, although, as we shall see farther on, for comfort and health there are other considerations to be kept in view.

Milk and Eggs.—These seem naturally to claim attention in the first place before entering on the consideration of animal food more strictly so called, because they are provided by nature as the sole food for the young.

Milk comprises all the necessary principles of which we have spoken—viz., the nitrogenous, non-nitrogenous, mineral, and water. The nitrogenous is represented by the caseine, or curd, and the fat, or hydro-carbon, by the cream; whilst the carbo-hydrates exist as sugar of milk, or lactos, as it is called. The remainder consists of water holding in solution certain mineral substances. The fatty matter, which exists in the form of minute globules, being of higher specific gravity, naturally rises to the surface when the milk has remained at rest for a little time, and thus appears in the form of cream. If longer exposed to the air, and the more speedily if the air be warm, as in summer, certain chemical changes take place, and the lactine, or sugar, is converted into lactic acid; the effect of this is to coagulate the caseine, which then falls down in a separate state, and the milk is said to be curdled. Other acids will produce precisely the same effect, and housewives know the importance of keeping their milk pans perfectly clean and free from all sourness. Now, it is important to know that precisely the same effect is produced by the juices of the stomach during the digestive process. When an infant throws up its meal in a curdled state, an ignorant nurse supposes that this is a sign that the milk disagrees or is bad. It is the natural change in the milk that takes effect as a part of the healthy process of digestion. It is the same principle that is applied in the making of cheese. When the curd and fatty matter are separated by means of what is called "rennet," which is obtained from the juices of the calf's stomach, what remains after the separation of the curd, which comprises the caseine and fat or cream, is called whey, and has very little nutritive value, consisting, as it does, merely of the sugar, saline matters and small quantities of the curd which has not been completely separated. It is useful, however, in the sick room, in feverish states, and where only small quantities of nutriment are needed or can be digested. In like manner, skimmed milk, from which the cream has been removed, being less rich, is better adapted for weak stomachs, but as it contains all the nitrogenous element it is far more nutritious than whey. In butter-milk, the fatty matter in the form of butter having been still more completely removed, all the other elements remaining, we have still an aliment possessing considerable nutritive value, particularly when taken with other articles of food.

The milk of different animals differs considerably in the proportion of the several constituents, as will be seen in the following table, given by Payen.

MEAN COMPOSITION OF THE MILK OF VARIOUS ANIMALS.

	Woman.	Cow.	Goat.	Sheep.	Ass.	Mare.
Nitrogenous Matter and Insoluble Saline Matter	3·35	4·55	4·50	8·00	1·70	1·62
Butter	3·34	3·70	4·10	6·50	1·40	0·20
Lactine and Soluble Salts	3·77	5·35	5·80	4·50	6·40	8·75
Water	89·54	86·40	85·60	82·00	90·50	89·43
	100·00	100·00	100·00	100·00*	100·00	100·00

From this it will be seen that the milk of the sheep, goat, and cow rank highest in the proportion of solid constituents which they contain, and the milk of the ass and mare lowest, whilst woman's milk holds an intermediate place, approximating more nearly to cow's milk than to that of the other animals. But the cow's milk is so decidedly the richer of the two as to show why, as experience has proved, it is generally necessary to dilute it somewhat when employed for the sustenance of very young infants. On the other hand, the less rich constitution of asses' milk shows why it is often better suited for infants and persons of very weak digestive powers than cow's milk. The abundance of the saccharine constitution, lactine, in mare's milk, explains its readiness to undergo the process of fermentation, and thus to the formation of that species of spirituous liquid which is largely employed by the Tartars and Persians as "Koumiss."

We have only further to observe that the milk of all animals is liable to be affected by the health of the animal as well as by its food. We all know that the richness, the colour, and the flavour of the cow's milk varies with the character of the herbage or other food on which the animals are fed. But it is perhaps not so generally known that it may thus be rendered poisonous by certain plants, though the creature yielding the milk may not suffer. Nursing mothers know that errors in their diet—acid fruits and certain medicines—will often render their milk injurious to the infant. Even mental disturbance, fright, or anxiety in the mother may excite convulsions or other serious consequences in the suckling. This has often been seen in a remarkable way in times of war and civil commotion. Sour milk—that is, milk which has undergone fermentative change—is always not only disagreeable but unwholesome, and will often induce diarrhœa and gastric disturbance. There is scarcely any article of food that requires more care in its selection, preparation, and preservation than milk; none is more easily rendered pernicious by foreign impregnation, especially by admixture with polluted water. It is to this that various outbreaks of typhoid fever have been traced. In towns the pump is too often had recourse to in order to increase the amount of that which should be obtained from the cow alone, and this often to such an extent that the fraud may be discovered by the appearance of the milk and the deficiency in the proportion of cream. The specific gravity of average good, pure milk is about 1,030, at the temperature of 60° Fahr. The amount of cream yielded and the specific gravity afford, for ordinary purposes, a rough but adequate test whether the milk has been diluted by water; but other careful scientific methods are required to detect the various ways in which this all-important food of the young and the sick is too frequently adulterated by unscrupulous vendors.

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* The correct addition does not correspond with these figures given by Payen.

Milk has sometimes been found deleterious from the presence of a particular fungus giving to it a blue tint, and hence the term "blue milk." How this is induced is not quite clear, but that such milk is capable of giving rise to severe gastric disturbance there can be no doubt. The fungus appears as a blue layer on the surface of the milk.

The condensed milk, which is now largely consumed, is merely milk from which much of the aqueous constituent has been driven off by heat, and then enclosed in hermetically-sealed tins. In some of these condensed milks some ordinary sugar is added. They are most valuable articles of food, and are available when fresh milk cannot be procured or cannot be long kept. Children brought up by hand thrive well on such milk. Nevertheless, good fresh milk is to be preferred for that purpose.

Butter, which is the fatty constituent of milk, is by the dairymaid separated from the rest by means of churning, the mechanical effect of which is to make the globules of cream run together, and then form a solid mass, which, when removed from the churn, is washed with the hand in water, with the view of separating extraneous matters. Salt is then added as a means of making it keep. All further manipulation is only injurious. Its flavour and aroma will depend, as in the case of milk, on the character of the pasture on which the cow has fed. Unless mixed with a large proportion of salt it very readily undergoes chemical change—becomes rancid, offensive, and unwholesome. Cold and complete exclusion from the air will secure its keeping much longer without undergoing change.

Cheese, the main constituent of which is the caseine of the milk, always contains more or less of the other components, and on the proportion of these, more than on the mode of preparation, depends the different character of the cheese. The larger the quantity of cream that is retained the richer the cheese; and when only poor and frequently-skimmed milk is used, the cheese is poor and hard. The richer the cheese the more readily chemical changes take place, and various volatile acids are produced, which give it the peculiar flavour and characteristics we call "cheesy." In the course of these changes it affords a ready nidus for the development of various minute organisms, both vegetable and animal, which appear in the form of mold, mites, and maggots, to which the epicure often does not at all object, but which render it objectionable and offensive to delicate stomachs.

Cheese properly made and of moderate richness is undoubtedly a valuable nutriment; nor when taken with other food is it, in moderate quantity, and as part of a meal, difficult of digestion. But the hard and tough poorer varieties require the strong stomach of the agricultural labourer; and as the effect of toasting is to reduce it almost to the consistence of leather, it is, in this state, as "Welsh Rabbit," a fertile source of indigestion and nightmare. That small quantities of cheese taken at the end of a repast act as a condiment seems to be very generally acknowledged; hence an old proverb—

> "Cheese is a surly elf,
> Digesting all things but itself."

Eggs, like milk, afford us a typical example of food containing all the different principles essential to the development and growth of the body, differing from milk principally in containing but a small portion of starchy matter as the representative of the carbo-hydrate principles. Both the white and the yolk consist largely of nitrogenous elements, and in the yolk we have these associated with the oily or fatty elements. We have also water and saline or inorganic matters. But as the process of incubation goes on, and more mineral matter is required for the bones and some other parts of the chick, this is supplied from the shell, which consists principally of carbonate of lime or hard chalk, by the gradual loss of which it becomes thinner and thinner till it may be broken by the slightest touch. The shell is penetrated by minute pores, through which air is conveyed to the chick during the process of hatching, as the oxygen of the air is necessary to the production of those changes by which the development of the young bird is effected. It is in this way also that air enters when an egg has been long kept, and brings about its putrefaction. This is proved by coating the shell by any material impervious to air, or by filling up the pores by rubbing the shell with fat, when it is found that the egg will keep for an almost indefinite time. The white of egg, consisting almost entirely of albumen, coagulates by heat, and this in a boiled egg becomes solid, and is in this state less easily digested, though not less nutritious. The yolk, containing less albuminous matter, does not so readily solidify by heat, and from containing a large quantity of oily matter easily floats in the white, from which it is separated by the surrounding membrane, termed the yolk bag. Eggs when lightly boiled or in the raw state are easy of digestion, though many persons cannot take them except in combination with other things, and in some instances they act as aperients. From the large percentage of fat contained in the yolk, an egg in this respect becomes equal to fat beef and other fat foods, such as pork and eels. But as the white or albumen is devoid of fat, when the whole of the egg is eaten it is less rich, while the tendency of the white to induce constipation is overcome by the fatty nature of the yolk. Like milk, eggs vary in flavour and richness according to the breed of the bird and its food. Various devices of the kind already mentioned are had recourse to by the merchants to prevent the transit of air through the shell, and thus retard or prevent putrefactive changes; but they take place so readily that for food, especially of the young and delicate and dyspeptic, the utmost care should be taken to have them fresh—*i.e.*, newly laid. Containing, as they do, a very large proportion of nitrogenous matter in a concentrated form, they constitute one of our most sustaining kinds of food, and when hard-boiled are convenietly carried on a journey, and with a little salt and bread and water will supply the pedestrian or labourer with all he needs to go through a hard day's work. Omelettes, pancakes, and fritters are chiefly objectionable from the presence of the fried butter and oil in which they are cooked. A properly-prepared omelette is, however, a dish that even a delicate stomach can digest with facility.

Having examined these two typical forms of animal food—eggs and milk—together with their separate derivatives, we come now to the consideration of those which more commonly are spoken of as—

ANIMAL FOOD.

This we may treat of under three heads, as—I. Meat; II. Poultry and other fowls, &c.; III. Fish.

I. *Meat*, or the flesh and other parts of animals used as food by man, is obtained entirely from the vegetable feeders. It is true that among savage and various semi-civilised tribes cats, dogs, otters, rats, and even lions, among other carnivora, are devoured as food. Even cannibalism has not yet altogether disappeared from the world, and man, in the most literal sense, feeds on man; but, unless we consider the pig an exception, civilised people confine themselves to graminivorous animals for the supply of their meat. Beef and mutton and bread, which are the staple foods of the Englishman, contain all those principles which we have seen are found in milk and eggs.

What is called flesh consists chiefly of muscle, which is made up of fibrous bundles, termed muscular fibre, which again consists mainly of fibrine. If a piece of fresh beef be dried in the sun or otherwise, so as not to burn it, it will shrivel up into a small bulk from the loss of its water, and be reduced in weight from 4 lbs. to 1 lb. If a piece of lean beef be washed in repeated waters it loses its colour, and the fibrous tissue remains as a white mass; if this be submitted to the action of ether a certain amount of oil or fatty matter will be removed, and it will then remain a dry, compact mass, composed entirely of fibrine, with the exception of the remains of the minute vessels by which the flesh was supplied with blood.

This lean part of the flesh, or muscles, consists therefore chiefly of fibrine, which is a highly nitrogenous principle. The fat supplies the hydro-carbon, and the water and the blood contain the requisite saline matter. But where, it will be asked, are the representatives of the carbo-hydrates—the starch and sugar? They are absent, and this it is important to remember. Of starch or glycogen there is little, and of a peculiar form of sugar only a trace, if any. With a view to impress this on the mind we give the following table, comparing the composition of meat and bread:—

	Lean beef.	Wheaten bread.
Water (and blood) and salines	78	45
Fibrine or gluten	19	6
Fat	3	1
Starch, &c.	—	48
	100	100

Here the fibrine and the gluten are considered as the same—that is, the nitrogenous element in the beef is represented by the gluten in the bread. The main difference, therefore, in these two chief articles of food is that the nitrogenous principle, the fibrine, is about three times as great in the meat as in the bread, and that the former contains no starch, which constitutes nearly half the bread. If, therefore, the nutritive value of food depends, as to a great extent it does, on the proportion of the nitrogenous element, a pound of beef steak may be said to be as nutritive as three pounds of wheaten bread; and inasmuch as fat represents and takes the place of starch, we have only to fatten our beef, or when this cannot be done, take some fat food—as bacon—along with the meat deficient in fat. This is what we do when we take bacon with chicken or veal, which are deficient in fat; but, in fact, in most of the beef and mutton that comes to our markets, at least a fourth of the whole dead-weight consists of fat.

Wild animals—*game*—generally have very little fat, while the flesh of many of the heavier fat sheep is three-quarters fat, as much as 20 lbs. of tallow being obtained from the carcase of a sheep weighing 55lbs. The oxen which are fattened for the Christmas market and for agricultural shows have the amount of fat enormously increased, which, being intermixed with the muscular fibre, as well as deposited in masses, gives to the meat its marbled appearance and somewhat paler colour than ordinary beef. The object of the grazier is to send his cattle to the market as fat as possible. But this is often carried to an undesirable extent, as far as the consumer is concerned, and entails much waste, and when effected by certain kinds of feeding—as with oil-cake—the fat is rendered yellow and oily. All meat is rendered more or less palatable by the different foods on which the animal has been fed. No mutton or beef is so good as that which has been fed on good herbage in upland districts; and stall-kept cattle, shut up and fed on dry, artificial food, give neither such good meat nor milk as those kept in a more natural way. Ox beef and wether mutton are preferred to the meat of cows and ewes, the quality of the beef and mutton being superior. The outward characteristics of good meat should be known to all housewives. The following are the characteristics given by Dr. Letheby in his "Lectures on Food":—

"1st. It is neither of a pale pink colour nor of a deep purple tint, for the former is a sign of disease, and the latter indicates that the animal has not been slaughtered, but has died with the blood in it, or has suffered from acute fever.

"2nd. It has a marbled appearance, from the ramifications of little veins of fat among the muscles.

"3rd. It should be firm and elastic to the touch, and should scarcely moisten the fingers; bad meat being wet, and sodden and flabby, with the fat looking like jelly or wet parchment.

"4th. It should have little or no odour, and the odour should not be disagreeable; for diseased meat has a sickly, cadaverous smell, and sometimes a smell of physic. This is very discoverable when the meat is chopped up and drenched with warm water.

"5th. It should not shrink or waste much in cooking.

"6th. It should not run to water, or become very wet on standing for a day or so; but should, on the contrary, be dry upon the surface.

"7th. When dried at a temperature of 212°, or thereabouts, it should not lose more than 70 to 74 per cent. of its weight, whereas bad meat will often lose as much as 80 per cent."

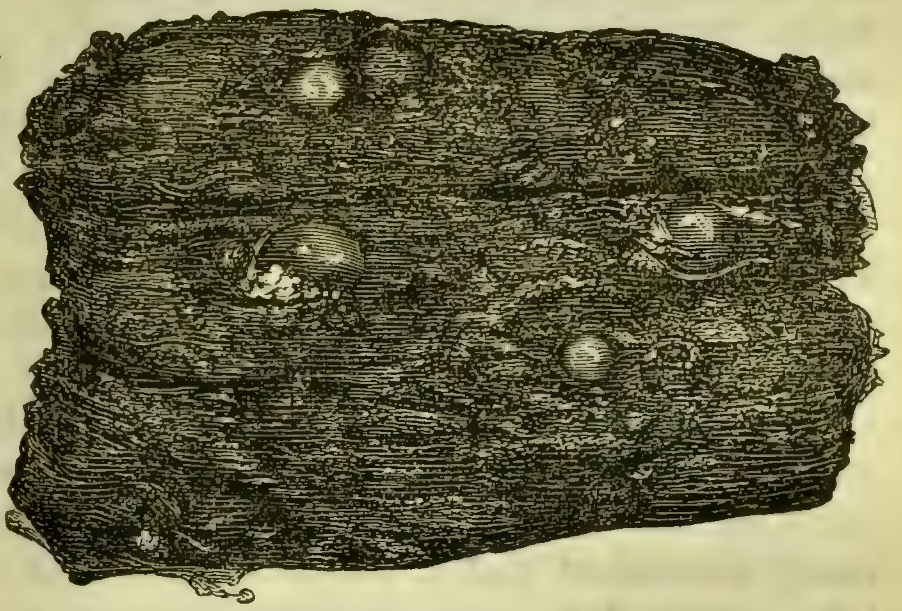
Unwholesome Meat.—The principal modes in which meat is rendered unwholesome are :—

1. By disease in the animal when slaughtered.

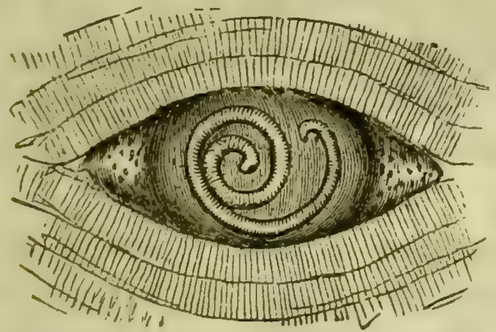
2. By the poisonous action of particular kinds of food or noxious agents taken during life.

3. By the changes induced by decomposition.

1. All animals are liable to be infested by various kinds of *parasites*, some of which are almost peculiar to certain animals. There are no more serious and fatal sources of unwholesomeness in meat, and it is of the highest importance that they should be recognised and avoided. What is called "measly pork" depends on the presence of a minute parasite termed the "Cysticercus cellulosæ." This is a small bladder-like creature, about the size of a hemp seed, surrounded by a cyst and embedded in the flesh. If introduced into the human body alive, as is the case if the meat thus infested be eaten raw or imperfectly cooked, it is developed into another form, and becomes a tapeworm, or "Tænia solium;" but if subjected to the prolonged heat necessary for complete cooking, the cysticercus is destroyed. Beef and veal are infested by a similar parasite, which, in the alimentary canal, develops into another variety of tapeworm, called the "Tænia medio-cannellata." In these cases the unwholesome meat only gives rise to a very troublesome disease, by which the health may be much impaired, but which is seldom productive of fatal consequences.



Measly Pork.
(From Parkes's "Manual of Hygiene.")



Trichina Spiralis coiled up in its Spindle-shaped Capsule or Cyst.

In recent years, however, attention has been called to the fatal consequences that have frequently followed from the eating of meat infested by a different kind of parasite, termed the "Trichina spiralis," from presenting the appearance of a hair or thread curled up. It occurs in two forms, either free or enveloped in a cyst. It has been met with in the flesh of various animals, and also in that of birds; but like the Cysticercus it is most common in pigs, and from its minute size and thread-like form is not easily discovered, except when encysted. It is killed when exposed to the temperature of boiling water.

In 1863 public attention throughout Europe was roused to this subject by a terrible calamity that occurred in Prussia. A number of guests, amounting to 103, dined together at a feast in a hotel, and, among other things, partook largely of smoked sausages. Within a month twenty of these guests had died, and of the remainder the greater part were made more or less seriously ill. These sad consequences were traced to the sausages made from a pig which had been observed to be out of condition when slaughtered. The remaining sausages and meat from which they had been prepared were found to be swarming with Trichinæ, and they were also found in the muscles of the people affected. When swallowed, this parasite appears to be set loose from its capsule in the stomach and intestinal canal, propagates with prodigious rapidity, and permeates the tissues of the body, and infests all the muscles. The symptoms to which it gives rise are of two kinds: irritation of the stomach and bowels, occasioning vomiting and purging, and then intense pain in the muscles; and a febrile state, resembling, more or less closely, the symptoms of typhoid fever, ending too frequently in death in the course of a few weeks.

Sheep and oxen, and other animals, are liable to the same diseases as those which affect man—both those of an ordinary and those of a contagious character. How far the flesh of animals, dying of such diseases, when taken as food becomes unwholesome and capable of inducing similar disease, or disease of any kind in man, is a question of extreme importance to the welfare of the community. It is certain that a very large quantity of meat comes into the market derived from cattle that have been slaughtered in a diseased state; but it seems to be pretty clearly ascertained that if the disease has been of a non-contagious kind, such as inflammation of the lungs, no particular harm ensues. But how is it in the case of animals that have died of eminently contagious diseases, such as the rinderpest? Specific instances are given by Mr. Simon, in his reports to the Privy Council, of fatal consequences arising from eating cooked meat derived from animals affected by "anthrax." And although different opinions have been expressed on this subject, and specific explanations attempted of such cases as Mr. Simon has cited, the use of meat obtained from animals affected by contagious disease ought not to be sanctioned.

2. The flesh of animals which have fed on certain *poisonous herbs* may be poisonous to man, though the animal itself has not suffered. Hares and rabbits and grouse may thus prove unwholesome or dangerous. Certain medicines given to animals before slaughtering have been known to occasion serious illness in those who have partaken of their flesh.

3. The *chemical changes* occurring during the processes of decomposition and putrefaction are well known to develop deleterious products, which are often productive of serious consequences when introduced with food. Most people are alive not only to the disagreeable taste, but also to the frequent digestive derangements arising from tainted meat. And yet by habit we become accustomed to, and highly approve of, many articles of food which are undergoing decomposition. High game, decayed cheese, caviare, and other similar things, are the delight of the epicure, whilst the Greenlanders and other tribes revel in the enjoyment of garbage in an advanced

stage of putrefaction. From the frequency with which certain kinds of cured meats become the cause of illness, it would appear that certain special products are then formed, the precise nature of which is not very well known. These effects are chiefly seen in the case of bacon, sausages, and dried meats. The remarkable antiseptic properties possessed by the gastric juice, there can be no doubt, enable it to counteract what would otherwise be the injurious effects of tainted foods. In the case of decaying cheese, digestion seems to be sometimes assisted by the products which are thus developed, which, in some way or other, appear to aid the gastric juice in that dissolution of all food which is the primary step towards digestion.

Mutton.—Of the ordinary meats consumed in our country this is the most generally useful, because it is among both the most nutritious and the most easily digested. Beef is commonly considered the more strengthening, but requires stronger digestive powers. Mutton, also, lends itself more readily to the culinary art—admits of being dressed in a greater variety of ways. There is also greater variety in the meat itself, the different breeds of sheep and their different pasturage making considerable difference in the flavour and digestibility. Mountain-fed mutton has generally less fat as well as a higher flavour than that which is fed on richer meadow pastures.

Veal and *lamb* have the characters of the flesh of all young animals, and though more tender are less digestible; this, however, is more the case with veal than with lamb. Veal, even if taken with bacon to supply its deficiency in fat, proves indigestible to very many people. Among all kinds of meat, however, pork is pre-eminent for indigestibility.

Various special parts of animals are largely employed as food, and require a few words of separate notice.

Sweetbread.—This is either the "pancreas" or the "thymus gland;" the one being situated near the stomach and the other near the throat. It is a delicate, nutritious article of food, of easy digestion; but is too frequently materially altered in character by the rich sauces in which it is served.

Liver, which is usually fried, is generally that of the calf, lamb, or pig. It is a coarse, undesirable food, and very apt to disagree with those who eat it. That, however, which is obtained from the goose, and which is known as "foie gras," is an article of luxury highly appreciated by the gourmand. The Strasburg "Pâté de foie gras" has a great renown among epicures, and the enlarged liver of the goose is said to have been one of the delicacies of the table among the Romans. The descriptions given of the method adopted at Strasburg to induce the enlargement of the liver of the goose are not calculated to meet with the approbation of a Society for the Prevention of Cruelty to Animals. The wretched creatures are confined in the dark in small coops, not large enough to allow them to turn round, and are gorged with maize and fattening food till their breathing becomes so oppressed as to make it necessary to kill them in order to avoid death from their diseased condition. The liver of a goose thus treated will weigh from one to two pounds, and from the animal itself, when cooked for food, as much as three or four pounds of fat escapes. It is said that fowls for the London market are sometimes fattened in the same cruel manner.

Kidney and Heart, consisting of a close, dense, fleshy substance, are articles of difficult digestibility; but the kidney may be rendered soft and tender by suitable cooking, and, being very sapid, is a popular article of nutritious food for persons in health.

Tripe consists of the first stomach of the ox, the muscular fibre of which differs from that of meat, is more easily disintegrated by the gastric juice, and is both nutritious and of easy digestion. It is generally boiled and eaten with onions to supply the sapor, in which it is so sadly deficient, although it contains a good deal of fatty matter.

Bones are calculated to make up nearly twenty per cent. of the whole animal, and as they comprise no small portion of most of the joints supplied us by the butcher, it is important to know how far they can be made available for food. The nutritive nitrogenous principle which they contain is almost entirely gelatine, which is the basis of soup, and of this they contain so large an amount as to make it very desirable that they should be fully utilised, at least in the dietary of the poor. To this end, they should be broken up into small pieces, and boiled for many hours. The gelatinous and fatty matter thus extracted, when added to soups or mixed with other food, as in the common French *pot au feu*, increase very materially the nutritive qualities of the other articles.

II. *Poultry and other Fowls.*—In its general aspect the flesh of birds differs considerably from that of sheep and oxen. It is generally of a darker colour, though different parts of the flesh of a fowl, as is well known, differ in this respect, the breast and the wing being whiter than the leg and the back. Different birds vary also in this respect. The flesh of ducks and geese, and of some of the wild fowl, is much darker than that of domestic fowls and turkey. But there is one leading distinction between the flesh of all birds and that of mammals: it is never mottled —that is, it does not contain fat intermixed with the muscular fibre, although in some birds, and in poultry specially fattened for the market, there may be a good deal of fat deposited in various other parts. The flesh of birds differs much in its delicacy of flavour and digestibility. The food also on which the bird has fed makes a great difference. Ducks and geese are well known to disagree with delicate stomachs, whilst a well-fed Dorking chicken affords one of the most suitable, acceptable, and nourishing foods for the young and delicate. Unless it be from feeding on some particular food, most birds may be eaten with safety, and, speaking generally, they are both nutritious and easy of digestion, whilst game, from its special flavour and tenderness, is generally appetising. It should not, however, be kept long enough to become what is termed high, as it is then apt to disagree, except with epicures, and becomes repulsive to many people.

These latter remarks apply also to *hares* and *venison*, but the flesh of *rabbits* has a closer fibre and a peculiar flavour, which render it less digestible by weak stomachs and a less favourite food. We need not attempt to enumerate various birds which are largely employed and more or less esteemed as wholesome and delicate food. Partridge, quail, snipe, woodcock, pigeon, ortolan, wild duck—all have their special characteristics, and constitute desirable additions to the larder. Those muscles which are most used become firmer, harder, and tougher than those which are less used; hence the difference in the character of the flesh of different parts of a bird. The woodcock flies most, and the partridge walks most; hence the woodcock's wing is the firmer and tougher, and that of the partridge the more tender, which epicures know well, and which is expressed in the old rhyme—

> "If the partridge had but the woodcock's thigh
> He'd be the best bird that ever doth fly."

The white flesh of birds is generally considered the more tender, and the dark flesh the more stimulant and the more savoury.

III. *Fish.*—Of edible fish, constituting wholesome, nutritious, and valuable food, there is an almost infinite variety, and should be an unlimited supply. But under this common designation there is great difference in the character and general suitability for food. White fish and red-fleshed fish, oily fishes and shell-fish, present great differences as articles of food. Fish in general is less rich in fat than ordinary butcher's meat, and in many instances it is richer in nitrogenous matter. The following table will show the chief differences between white fish, such as cod, sole, or turbot; red-fleshed fish, such as salmon; and one of the most oily fishes—eels.

	White Fish.	Salmon.	Eels.
Nitrogenous Matter	18·1	16·1	9·9
Fat	2·9	5·5	13·8
Saline Matter	1·0	1·4	1·3
Water	78·0	77·0	75·0
	100·0	100·0	100·0

The quality of fish as an article of food varies with the season, the character of the feeding ground, the length of time that it is kept, and the treatment to which it is subjected after being caught. There is great difference between cod and salmon in season and out of season. It is just previous to spawning that the fish is in the highest condition: it is then fatter, and has a richer flavour. Herrings and mackerel are best eaten immediately after being taken out of the water; the ray, and some other cartilaginous fish, are improved by allowing some hours to elapse. Both fishermen and epicures know that a particular fish that has fed in certain grounds and at certain depths is superior to the same species of fish caught in another locality. Thus, Loch Fyne herrings and Dublin Bay haddocks have a reputation beyond others. The sturgeon varies in character so much according to its principal food as to have received corresponding specific designations, such as the mackerel sturgeon and the herring sturgeon. Dogger Bank cod is more flaky than the Scotch cod, which is more tough and woolly. *Crimping* consists in making transverse incisions through the flesh before the fibres have lost their vital power, before that stiffening which is called the *rigor mortis* sets in. The fish is then thrown into cold water, and the effect is to cause a strong contraction of the flesh and render it of firmer texture. Salmon, when treated in this way, and thrown into strong salt water, may be rendered so hard and friable as to be objectionable.

As a rule, white fish is more digestible than red fish, and the less oily are more digestible than those abounding in oil. The least digestible of the white fishes are probably the sturgeon and cod, especially in certain conditions—such as when the latter is tough and leathery. Most fresh-water fish, whiting, haddock, flounders, soles, and plaice are among those the most easily digested and the best suited for weak stomachs. Turbot and brill, and, among the richer fish, salmon may be viewed as generally the most available of the more solid and nutritive species. Herrings, when perfectly fresh and deprived of their skin, are sweet and palatable, and though one of the fatty fishes, will not generally, if properly cooked, disagree with delicate stomachs. Salmon, considered the king of fishes brought to table, is among the most satisfying and highly nutritious of fishes, and its ill-reputation with many dyspeptics is probably more frequently due to the adjuncts with which it is eaten, or to its bad condition, either from being out of season or having been too long kept. The latter reason too frequently may be assumed, for, being a highly-priced fish, there is great temptation to subject it to various devices for preserving it by artificial means and selling it when it has already undergone change. Sprats and pilchards are strong food not to be recommended, but eels and lampreys are generally cooked so as to be made savoury dishes, and are enjoyed by those who are blessed with tolerably good digestion. The oily fishes being always the most difficult of digestion, it is remarkable that common practice tends to reduce even the most digestible of white fishes to the same rank by the addition of melted butter, lobster or shrimp sauce, and by the amount of fried fat that is attached to badly-fried fish. Olive oil is much less objectionable for frying purposes than butter or lard; but plain boiled fish is undoubtedly the most wholesome.

Shell-Fish.—Both the Crustaceans and the Molluscs yield us several fish that hold a high rank as nutritious articles. They are often, however, possessed of poisonous or irritating qualities that render it necessary to use them with caution. Most of the Mollusca are susceptible of being rendered highly poisonous, particularly mussels, and many persons manifest a peculiar susceptibility to the irritant action of the Crustacea, such as lobsters and crabs, which are quite innocuous to other people. So singular is this susceptibility that we have known persons who could not handle a lobster and could scarcely pass one on a fishmonger's stall without having an attack of nettle rash. There are two classes of symptoms that arise from the poisonous action of shell-fish, the one characterised by gastro-intestinal irritation, vomiting, and purging; the other by nervous symptoms, convulsions, partial paralysis, and stupor. Death has ensued in both ways. Unfortunately, there is often nothing to indicate these poisonous qualities before the fish is eaten. Many people, therefore, have a dread of all shell-fish. But the lobster, crab, crayfish, shrimp, and prawn, among the Crustacea, and the oyster, among Molluscs, must be ranked among valuable and nutritious articles of food. They must, however, be classed with those fish which are difficult of digestion, and many persons with tolerably good digestive powers complain of a load in the stomach after eating freely of either lobster or crab. Shrimps and prawns are generally easier of digestion than either crab or lobster, whilst their delicate flavour renders them universal favourites. Oysters in the raw state are more wholesome than when cooked, the effect of heat being to coagulate and harden them. The firm, hard part of an oyster consists of the thick muscle by which the shell is closed, the power of which may be judged of by the difficulty of opening an oyster. The central, bulky portion consists chiefly of the liver and is the most readily digested—this alone should be taken by persons of weak digestion. There is considerable difference of opinion and of experience as to the digestibility of oysters. But from the time of the Romans to our own day they have been highly esteemed as nutritious articles of food. The smaller, common kinds of shell-fish, such as cockles, periwinkles, &c., should be avoided. The almost universal employment of vinegar, pepper, and salt, and olive oil in many cases, as condiments with shell-fish, appears to be founded on sufficient reason as well as experience. They facilitate the action of the gastric juice in disintegrating the solid fibrous material, and thus aid their digestion.

VEGETABLE FOOD.

As we have taken milk and eggs as the types of animal food, so we may take wheaten bread as the type of vegetable food. There are other cereals besides wheat which are used in the making of bread, and there are various foods, both of man and animals, of all which wheaten bread may be considered the type. The cereal and the leguminous seeds which rank first in importance among vegetable foods are often spoken of as farinaceous seeds, from the Latin farina, or flour. Of these the principal are wheat, oats, barley, rye, Indian corn or maize, and rice among the cereals; and peas, beans, and lentils among the leguminosæ.

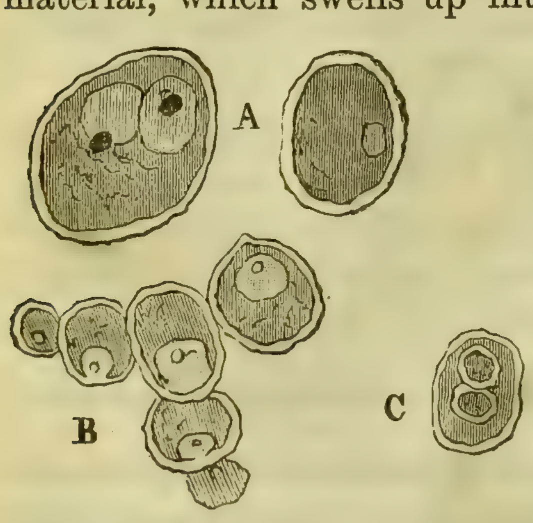
The various *cereals* correspond in a striking degree in their composition, but vary in the proportion of the several constituents. They contain all the essential alimentary principles of which frequent mention has been made. Their composition will be seen from the following table of dried cereals. (Payen.)

	Hard Wheat.	Rye.	Barley.	Oats.	Maize.	Rice.
Nitrogenous Matter	20·00	12·50	12·96	14·39	12·50	7·55
Starch	63·80	64·65	66·43	60·55	67·55	88·65
Dextrine	8·00	14·90	10·00	9·25	4·00	1·00
Cellulose	3·10	3·10	4·75	7·06	5·90	1·10
Fatty Matter	2·25	2·25	2·76	5·50	8·80	0·80
Mineral Matter	2·85	2·60	3·10	3·25	1·25	0·90
	100·	100·	100·	100·	100·	100·

It will be observed that there are two principles mentioned here which do not occur in the table given of milk, the typical animal food—viz., dextrine and cellulose; but dextrine is but a modification of starch, and cellulose is the material which forms the basis of the cells and vessels of plants analogous to woody fibre or lignin, neither of which are of any value in a nutritive point of view.

It is of more importance to mark the different proportions of nitrogenous matter and starch in the different grains. Wheat, it will be observed, stands pre-eminent in its proportion of nitrogenous matter, whilst rice, which has the smallest proportion of nitrogenous matter, has the largest amount of starch. These differences correspond to their respective values as nutriments.

Wheat being the most important of all the farinaceous seeds, as from this we obtain what by emphasis is called *bread,* the principal food of man, we shall confine the following remarks chiefly to this grain. When ground between the mill-stones and sifted, it is separated into two parts—bran and flour. The bran is the outside and harder part of the seed, and is of darker colour than the interior. Although not devoid of nutriment inasmuch as it contains some nitrogenous material, it is used chiefly for feeding cattle. If now we take the flour and mix it with water, so as to moisten it thoroughly, it forms a tenacious mass termed dough, which may be drawn out and moulded into various forms. In this way macaroni, vermicelli, and the various kinds of Italian paste are formed. If this dough be placed on a fine sieve, or muslin stretched over the edges of a vessel, and rubbed and washed with water as long as the water passes through milky, there remains on the sieve a white, sticky mass like bird-lime, and the vessel beneath will contain the starch, which, after being allowed to rest, falls to the bottom, leaving the water above clear. The sticky mass, from its glutinous character, is called "gluten," and is the chief nitrogenous constituent of the flour. It constitutes about 10 per cent. of fine good flour. The bran, which as we have said is not devoid of nutritious matter, is made up of the two layers of cells which form the coating of the seed, the outer of which is dense and woody, and contains but little nutritious matter, whilst the inner coating is rich in nitrogenous material, containing as much as from 14 to 20 per cent., all of which is lost when the flour is prepared so as to make it as white as possible, by depriving it of this finer bran called "pollard." It is owing to the physical characters of the gluten that flour is fitted to be made into bread. When yeast is added to the dough fermentation ensues, bubbles of gas (carbonic acid) arise, and are entangled by the tenacious material, which swells up into a spongy mass, being everywhere permeated by the bubbles of gas, and thus rendered porous or "light." When put into the oven in this state, the fermentation is arrested, and the whole hardens by the coagulating action of heat into the solid but light and spongy substance called bread. Fermentation is, therefore, essential to the making of bread proper. In other cases where the dough is baked without undergoing this process, we have a species of biscuit, not bread. Fermentation results from the peculiar action exerted by yeast on moist flour.[*]



YEAST-CELLS UNDER THE MICROSCOPE.

(A) Single Yeast-Cells at rest, one with two vacuoles; (B) Chain of Yeast-Cells produced by budding; (C) Yeast-Cells containing Spores.

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[*] The nature of the action of the yeast fungus *Torula Cerevisiæ* in inducing fermentation is still somewhat of a mystery. From a few isolated cells, as shown in the illustration above, others are rapidly produced, and by their aggregation assume the character of a filiform plant, which grows with amazing rapidity. "Each yeast-grain or cell consists of a

It first changes a part of the starch of the flour into sugar, and then converts that sugar into alcohol and carbonic acid gas. The same changes take place in the brewing of beer. As the gas is confined by the glutinous dough it collects in bubbles of smaller or larger size, making the whole mass swell until the heat of the oven kills the yeast plant, when the fermentation is arrested. The alcohol which is formed is to a great extent driven off during the baking; but a small portion is retained along with the water in the bread, for a large portion of water—as much, it is said, as 40 per cent.—exists in well-baked bread. Newly-made bread is soft and tenacious, and may be rolled between the fingers into a solid, adhesive mass, whereas stale bread crumbles into separate particles. This does not arise simply, as is supposed, from loss of moisture, as may be proved by putting a stale loaf into a closely-covered vessel and exposing it for a short time to heat in the oven, when it is found to have regained to a great degree its softness and pliancy. Stale bread, unless very old, appears on analysis to contain almost as much water as new bread when cold; but some change takes place in the internal arrangement of the molecules which alters its consistency. New bread, however, is generally preferred to stale, as more palatable; it is, however, much less digestible. This arises from its clogging together during mastication, so that when swallowed it passes into the stomach in a less porous state, and so is less easily acted on by the gastric juices. Many persons of fair digestive powers find that after eating heartily of new bread they are uncomfortable and oppressed by a sense of weight at the stomach, and persons of feeble digestion may have a severe fit of indigestion induced by eating new bread. The effect of toasting, on the other hand, is to render the bread more friable and easily penetrated by the gastric juice, and so more readily digested. Toast should, however, be thin and crisp on the outside, and eaten soon after it is made; when cut too thick and kept too long after toasting, it is rendered tough and leathery, and the whole object of toasting is lost. When properly made, and eaten when sufficiently cold not to melt the butter spread on the surface, it constitutes a wholesome mode of taking bread; but hot buttered toast—that is, toast saturated with hot melted butter—should be eschewed by all persons of weak stomach as exceedingly objectionable.

When made with sour yeast, or when the process of fermentation is imperfectly conducted, or when leaven (*i.e.*, sour dough) is used instead of yeast, the bread is often rendered "sour," as is well known to those who have travelled much on the continent. With some stomachs, also, even the best fermented bread disagrees,

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little bag or sac, made of the same colourless transparent substance which forms the fibrous matter of wood. This bag contains a jelly-like substance, and inside the jelly are one or two clear spaces. Each cell is alive and grows, and is capable of reproduction. Whenever the yeast cells are in contact with a liquid that easily undergoes fermentation, they begin to give out one or two little prominences from their sides. These prominences grow larger by degrees, and into them part of the contents of the parent cell flow, leaving an empty space or vacuole in the parent cell. The little buds, when full grown, split off from the sides of the parent cell—generally, however, not before they themselves have given rise to buds, and these in turn to others (as in B in the figure)—thus forming branching chains of linked cells. The original parent cell, after having given rise to several generations of buds, dies and bursts, its contents mixing with the liquid. Multiplication may also take place by small cells (spores) forming themselves in the interior of a yeast-cell, and being finally set free by the bursting of the sac of the parent cell."—"Science for All," Vol. I., p. 51.

and various methods, therefore, have been devised to obviate these objections, and produce an equally light and porous bread without fermentation. There are several ways of making unfermented bread, by which time and trouble may be saved, and all risk from bad yeast or over-fermentation avoided. The principle involved in all is to open out the dough and render it light and spongy by the action of carbonic acid driven into the mass, or generated within it, before baking. This is effected either by Dauglish's process, or by the various baking powders that are sold. Passover cakes, or the unleavened bread of the Jews, is a biscuit, and not true bread.*

Of biscuits there are, in the present day, innumerable varieties, and the popularity of this kind of wheaten food among the British is now extending to the continent, where till recently a genuine biscuit was almost unknown. Some of these, which we call plain biscuits, are made simply of flour and water, and vary in thickness, hardness, form, and general aspect, according to the baker's ingenuity. From being well dried as well as baked, they possess the great advantage of keeping. Hence they are largely used in the navy; but the common ship-biscuit, though a good and wholesome food, requires that Jack Tar should have good teeth, unless he soaks his flinty food in his cocoa or other fluid. It may, however, be brought back into the condition of new biscuit by being moistened and re-baked, like stale bread.

Other kinds of biscuits, most of which pass under the denomination of sweet biscuits, are made by the addition of milk, butter, and sugar. In cracknels—the technical details in the manufacture of which are quite peculiar—eggs are used. Various degrees of lightness and friability are given partly by particular methods of manufacture and partly by having recourse to some baking powder or other alternative. Of fancy biscuits the name is legion, and one of our largest firms of biscuit bakers is said to produce no less than 150 varieties. Carraway seeds, ginger, and other special articles are introduced in many cases. The biscuit which goes by the name of the celebrated surgeon Abernethy is a plain biscuit with a little sugar and some carraway seeds, and is a most useful and digestible article, the carraway seed affording a pleasant, aromatic, and stimulant addition. True gingerbread, as distinct from various kinds of biscuits containing ginger, is a bread, or cake, rather than a biscuit, and contains treacle, butter, ginger, and carbonate of potash. The treacle contains certain acids, by the action of which on the potash the carbonic acid is set free, and thus the spongy bread character is given to the mass.

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* There are several formulæ for making unfermented bread, which are available for private families. The following is given by Dr. Pereira as answering well:—

Flour, 1 lb.
Sesquicarbonate of Soda, 40 grains.
Cold water, half a pint, or as much as may be sufficient.
Muriatic acid of the shops, 50 minims (drops).
Powdered white sugar, a teaspoonful.

Mix well the soda and sugar with the flour in a large basin by means of a wooden spoon. Then gradually add the water with which the acid has been previously mixed, stirring constantly so as to form an intimate mixture very speedily. Divide into two loaves, and put into a quick oven immediately. If any soda escapes the action of the acid, it causes a yellow spot, which, however, is more unsightly than detrimental. The sugar may be omitted if thought desirable.

Borwick's Baking Powder enjoys a well-merited reputation. It may be closely imitated by using a mixture of equal parts of tartaric acid and bicarbonate of soda.

German Yeast and similar articles consist simply of dried yeast, so prepared as not to kill the yeast plant ("Torula Cerevisiæ"). They therefore yield a fermented or leavened bread identical with that obtained by the use of fresh or brewer's yeast.

Tea Cakes are made with flour, butter, milk, and sugar, and from these *Rusks* and *Tops* and *Bottoms* are made by slicing the cakes and drying and slighly browning them in the oven. They are largely used as children's food, for which they are well adapted and very useful. But they are inferior to biscuit powder—*i.e.*, plain well-made biscuits ground down, by which the cohesiveness of the biscuit has been overcome, and which is still further effected when boiled.

Muffins and *Crumpets* need not be described, as they neither come under the head of food of health nor of sickness, except it be as highly conducive to the latter state.

Macaroni, *Vermicelli*, and *Italian Paste*, of which mention has already been made, and *Semolina* and *Soujee* are all granular and other forms of wheat flour rich in gluten. They are used as additions to soups and as the basis of various puddings, and it need scarcely be said are highly nutritious. Macaroni, on which the Italians to a great extent live, is not so much used among ourselves as it might and should be. When properly prepared, well boiled in milk, and made thoroughly soft, it is easy of digestion as well as highly nutritious, and admits of being taken in various ways. It most advantageously takes the place of vegetables with animal food, when the former are inadmissible. When dressed "à la Napolitana"—that is, with meat gravy or strong soup poured over the well-boiled paste—it forms a palatable, nutritious dish. In the common form of macaroni cheese it has to contend with one of the most indigestible of foods, toasted cheese, which, however, with the aid of mustard and pepper, is made subservient to the epicure's behests.

Oats and Oaten Food.—The oat cultivated in this country is the *avena sativa*, or common oat. Its composition, as compared with wheat, we have given in the table, page 117. When deprived of their outer integument, oats are called groats or grits; these when crushed become "embden groats," and when ground prepared groats. Common oatmeal is prepared by grinding the kiln-dried grain deprived of the outer coverings or husk. It is not so white as fine wheat flour, and has a slightly bitter taste. The definition of oats given by Dr. Johnson, so uncomplimentary to Scotchmen, we will not quote, but one of the most celebrated Scotch physicians, Dr. Cullen, says, "Oatmeal is especially the food of the people of Scotland, and was formerly that of the northern parts of England—counties which have always produced as healthy and as vigorous a race of men as any other in Europe."

Although rich in nitrogenous material, oatmeal is not generally considered equal in nutritive value to wheat flour, though probably but little, if at all, inferior. Being deficient in gluten, it cannot be vesiculated and made into bread like wheat flour. What is called oat bread or cake is, in fact, an unfermented bread or biscuit. It is in this form, or as porridge, that it constitutes the staple food of Scotland and other northern countries. With those who are unaccustomed to it, it is apt to disagree, occasioning heartburn and irritating the bowels. As porridge, or stir-about, which consists simply of the meal well boiled, it admits of being combined with various nutritive articles such as milk, treacle, butter, &c. It is also a valuable addition to both vegetable and animal broths.

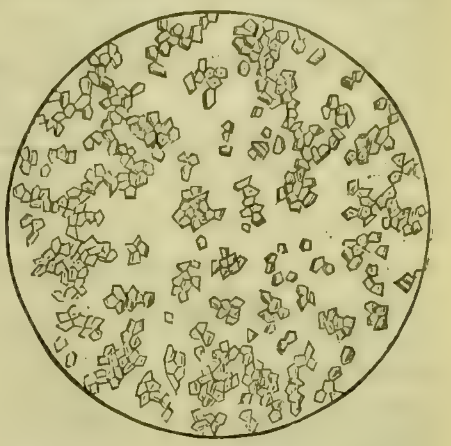
Barley.—Of this cereal there are several species cultivated in this country. The grains when deprived of their husk constitute Scotch, milled, or pot barley, and when all the integuments are removed, and the seeds are rounded and polished, they are termed *pearl barley*, which when ground to powder becomes *patent barley.* For its composition as compared with wheat, we again refer to the table, page 117. The nitrogenous matter exists chiefly in the form of albumen and caseine, there being very little gluten; hence, as in the case of oatmeal, barley meal does not admit of being made into true bread, but requires the admixture of a certain portion of wheat flour. When thus made it is considered less digestible than common bread, and to have a slightly laxative action. Densham's farinaceous food is a mixture of wheat and barley flour that has been submitted to heat in a baker's oven for a few hours. By this means it loses water by evaporation, acquires a kind of pea flavour, and will keep well. It constitutes a very nutritious food that lends itself usefully to the culinary artist as a basis for puddings, &c.

Malt is barley which has been made to germinate by moisture and heat, and then dried. A peculiar nitrogenous principle is thus developed which has received the name of "diastase," which has the power of converting the starch into dextrine and sugar, preparatory to the fermentative process of brewing. Liebig's food for infants consists of malt and wheat flour, cow's milk, bicarbonate of potash, and water in such proportions as to make it represent woman's milk as regards its nutritive properties.

Rye.—The ordinary cultivated species is the *Secale cereale* of the botanist. It is a common food of the northern inhabitants of Europe, but is rarely employed in this country. The nitrogenous matter of rye meal existing, to a certain degree, in the form of gluten, it admits of being made into vesiculated bread, and is well known in Germany as "schwartzbrod," or black bread. Although but little inferior to wheaten bread in nutritive value, its colour and acid taste make it disagreeable to persons unaccustomed to it, and it also has a decidedly laxative effect. It is given to horses when employed in long, continuous work, and proves a sustaining and speedily-digested food.

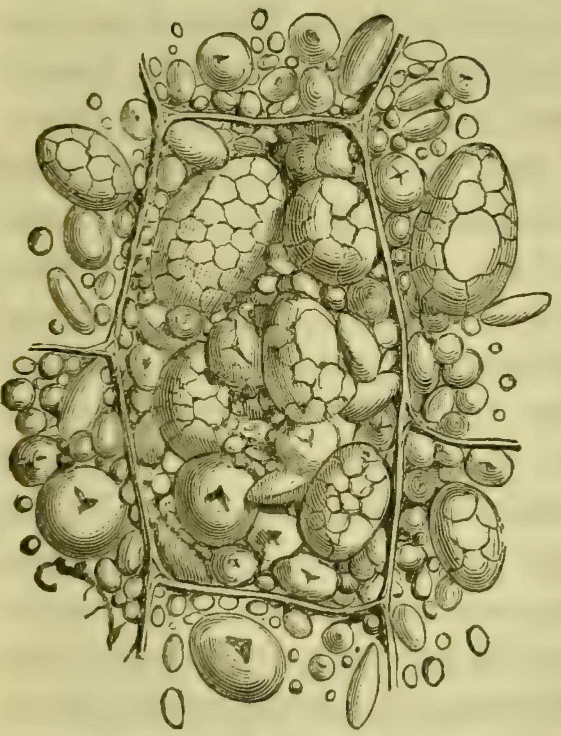
Rye grain has, however, a special interest from being liable to become attacked by a parasitic fungus termed *Ergot*, which causes the seed to grow out in the form of a spur, whence the grain, when so affected, is termed spurred or ergotised rye, and the very fatal disease produced by eating such diseased grain is called "Ergotism." This remarkable disease assumes two forms—the one called convulsive, and the other gangrenous ergotism. In the one case, the patient becomes the subject of giddiness, impaired vision, and violent convulsions; and in the other, of coldness and loss of sensation, and, ultimately, mortification of the extremities. The peculiar alteration of form assumed by grain thus affected affords a ready means for its detection.

Rice.—This is the seed of the *Oryza sativa*, of which there are innumerable varieties cultivated. Whilst in the husk it is called "paddy." It is largely grown both in the old and new world. The best kinds brought to this country are known as Patna and Carolina rice. It is said to constitute the principal food of nearly one-third of the human race. Marsden, in his "History of Sumatra," says, "Rice is the grand material of food on which a hundred millions of the inhabitants of the earth subsist, and although chiefly confined by nature to the regions included between and bordering on the tropics, its cultivation is probably more extensive than that of wheat, which the Europeans are wont to consider as the universal staff of life." A reference to our table, however, will show that rice is less nutritious than wheat, inasmuch as it contains a much smaller proportion of glutinous or nitrogenous material; and from the large amount of starch which it contains it resembles the potato. It does not admit of being made into bread, except with the addition of wheat flour and other things. Its action on the digestive system is rather astringent than laxative. It does not, however, contain any true astringent principle, but being light, digestible, and unirritating, it becomes a suitable article of diet in cases of diarrhœa and similar disorders. It is generally eaten whole, and should be cooked by steaming rather than boiling, as by the latter method it loses much of its nutritive quality. Its value as food, in connection with the large amount of starch which it contains, we shall have occasion to refer to again.



GRANULES OF RICE STARCH. (*Magnified*).

Maize or Indian Corn is the fruit of the *Zea Mays*, a native of Central America. It is now extensively used as food both in America and Asia, and in many parts of Europe. Being deficient in gluten, it is not adapted for bread, but, like oatmeal, is made into cakes, termed in America "Johnny cake." With milk, eggs, and admixture of other flour, it is made into a variety of puddings and cakes, which constitute wholesome and nutritious aliment. If eaten alone it is apt to produce diarrhœa, and its peculiar flavour is disagreeable to those who have been unaccustomed to its use. The young grains from the unripe ears make a delicious but rather over-sweet vegetable for the table, available when the season for green peas is over. In this state, also, it is much easier of digestion. Containing, as it does, a large amount of oily or fatty matter, it is largely used for fattening poultry and other animals. The articles now largely sold under the names of Oswego flour and corn flour are maize flour that, by means of a weak solution of soda, has been deprived of its peculiar, unpleasant flavour. Maize has lately been introduced into Ireland to take the place of the potato, to which it is undoubtedly much superior as a staple article of food. The dish called by the Italians "polenta" is maize meal made into a porridge, generally with the addition of cheese.



GRANULES OF MAIZE STARCH (*Magnified.*)

Leguminous Seeds.—These constitute a distinct class of seeds, affording farinaceous food, and are characterised by containing a smaller proportion of starch and a larger proportion of nitrogenous matter, existing chiefly as legumine, which we have said represents the caseine of animal food. There are three of this class of seeds, which are extensively used as food—viz., beans, peas, and lentils. Their composition, as given in the following table, should be compared with that of the cereals given in the table, p. 117.

COMPOSITION OF BEANS, HARICOT OR FRENCH BEANS, PEAS, AND LENTILS, AS GIVEN BY PAYEN.

	Dried Green and Skinned Broad or Windsor Beans.	Haricot or French Beans.	Peas, Dried.	Lentils.
Nitrogenous Matter ...	29·05	25·5	23·8	25·2
Starch, &c.	55·85	55·7	58·7	56·0
Cellulose	1·05	2·9	3·5	2·4
Fatty Matter	2·00	2·8	2·1	2·6
Saline Matter	3·65	3·2	2·1	2·3
Water	8·40	9·9	8·3	11·5
	100·0	100·0	98·5*	100·0

It will be at once inferred, from a consideration of this table, that their nutritive value must rank high. And such is the fact. Nevertheless, in a dietetic point of view, they are inferior to the cerealia. Experience proves that they are less easy of digestion, liable to occasion flatulent disturbance, and to prove heating and stimulating. When constituting the main sustenance, in the absence of animal food, they are most advantageously taken with fatty or oily substances, or with some of the cereals less rich in nitrogenous material—such as rice. Thus, from time immemorial almost, broad beans have been associated with fat bacon, the French haricot beans with olive oil or butter, and the lentil with barley or other flours. This latter combination constitutes what is sold as "Revalenta Arabica" and "Ervalenta." Sometimes Indian corn flour is used instead of barley flour, and sometimes certain flavouring ingredients and sugar are added. Various trifling modifications of this kind are sufficient to give a new name, to serve advertising purposes. The lentil flour gives the compound a certain laxative property; but it is a mistake to suppose that it is generally either more digestible or more wholesome than cereal flours. The common broad bean, when young and green, is to most persons an acceptable and wholesome variety of fresh vegetable, and the French haricot bean, when thoroughly boiled and rendered mealy, is a good substitute for the potato, and will often agree when the potato cannot be taken. The scarlet runner is a distinct variety of bean (*Phaseolus*), and is generally eaten green, the pod and seed together. The garden pea of this country is also eaten when green, and when young and fresh is a wholesome and easily-digested green vegetable, but is far otherwise when old. Few articles of food are then more difficult of digestion, nor can they be rendered soft and tender by any amount of boiling. The meal of the dried pea is chiefly employed as an ingredient of soup, when, if well boiled, it becomes a nutritive addition.

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* The figures are those given by Payen, and do not amount to 100·0.

Oily Seeds.—To this class belong the almond, walnut, hazelnut, pistachio nut, and the cocoa-nut, with a few others. They contain nitrogenous and other compounds rendering them nutritious, but also a quantity of fixed oil, which unfits them for weak stomachs.

The *almond,* however, demands special notice, as it is largely used in cookery in ways that are sometimes dangerous as well as objectionable. The sweet almond when taken in large quantities, even when fresh and deprived of its skin, as "bleached almonds," is apt to induce a fit of indigestion from its solid texture and the large amount of fixed oil which it contains, and when stale this oil becomes rancid, and is still more obnoxious to a weak stomach. Eaten in the unbleached state with the skin or husk on, it has often been known to occasion puffy swelling of the eyes and face, attended by nettle rash. Bitter almonds are more or less poisonous to all animals, in consequence of the presence of a peculiar crystalline principle called amygdalin. This, when moistened by water or the juices of the stomach, reacts on other constituents of the seed, and there is formed a volatile oil, "oil of bitter almonds," and hydrocyanic or prussic acid. The sweet almond is devoid of amygdalin, and no such poisonous products ensue on its being eaten or mixed with water. Too much caution can scarcely be exercised when using bitter almonds for flavouring purposes, or the essential oils sometimes sold under different names, but possessed of the same deleterious properties as the oil of bitter almonds. A single drop of this oil has been found sufficient to kill a cat in five minutes, and twenty bitter almonds have sufficed to kill a dog in six hours. Numerous instances are on record of fatal results in the human subject from the accidental or careless employment of this most dangerous article. It ought never to be allowed in the hands of the cook, at least in its concentrated form, and the bitter almond itself requires to be used with great care.

The common *chestnut,* the Spanish or sweet chestnut, is not an oily seed, nor does it contain any deleterious principle. It is extensively used as food in Italy and some other countries. Containing a considerable proportion of starch and sugar, it has no small nutritive value; but in the uncooked state is very difficult of digestion, as are also the common hazelnut and the walnut. The pistachio nut and cocoa-nut are largely consumed in their native countries, and the fluid central portion of the cocoa-nut, or "milk" of the cocoa-nut, is a refreshing, wholesome drink in hot countries.

Roots and Tubers.—A large number of roots and tubers are used as food. They vary considerably in their digestibility and nutritive value. By far the most important of the whole class is the *Potato,* which is a tuberous outgrowth of the underground stem of the *Solanum Tuberosum,* one of the solanaceæ, a tribe which comprises some of the most poisonous plants. Among these may be mentioned the Deadly Nightshade, the Belladonna, Henbane, and Tobacco. The fruit of the potato itself is acrid and poisonous, although the tubers are entirely devoid of any deleterious principle, or if there be any, it is destroyed by the process of cooking.

The potato, which now constitutes so important a part of the food of both man and animals throughout the greater part of the civilised world, and may be said, indeed, to rank next in importance to the cereals, is of very recent introduction into Europe. It is commonly, but erroneously, supposed to have been first brought to this country by Sir Walter Raleigh. He, however, had been preceded by both Captain Hawkins and Sir Francis Drake, the former having introduced it to Ireland from North America in 1565, and the latter to England twenty years subsequently. It was, however, through Sir Walter Raleigh that it first received due attention in England as a valuable article of food. The potato mentioned by Shakespeare was the sweet potato, an entirely different thing, derived from the *Batatus Edulis*, now but little used, though forming a wholesome, slightly laxative, farinaceous food.

So late as 1719, there is no mention made of the potato in some of the horticultural works published at that time, whereas now it is widely cultivated throughout the globe as one of the most important agricultural products.

Of late years considerable alarm has been felt lest we should be deprived of this popular and useful article of food. In 1845 the plant became the subject of a serious disease, by which whole crops were destroyed, and famine resulted in Ireland and other places where the potato had become the main sustenance of the populace. Various opinions have been entertained as to the origin and nature of this disease. Suffice it to say that it involves the whole plant, beginning in the leaves and proceeding through the stalk to the underground stem and the tubers.

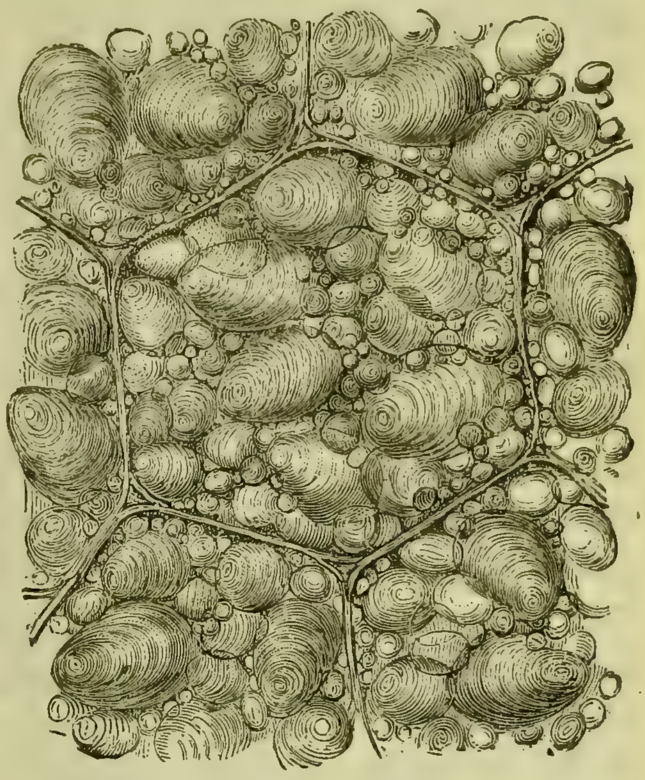
There are many varieties of potato brought to market, but the tubers of all have the same general characters, although they differ in their edible qualities. They have a solid firm texture, are surrounded by a thin epidermis, beneath which is another covering of a dark colour, and are studded with young buds termed "eyes," from any of which new plants may be reared. The substance of the tuber is made up of cells containing and surrounded by an albuminous fluid and a number of starch grains. The composition, as given by Payen, is as follows :—

Nitrogenous matter	2·50
Starch	20·00
Cellulose	1·04
Sugar and gummy matter	1·09
Fatty matter	0·11
Pectates, citrates, phosphates, and silicates of lime, magnesia, potash, and soda	1·26
Water	74·00
	100.00

The points to be particularly noticed in this table are the large proportion of starch, the moderate amount of nitrogenous matter, and the great variety of salts.

The chief character of the potato as food is the large proportion of starch which it contains. This varies somewhat in different varieties, but is always greatest in winter. In spring, when the vegetative process commences, and the buds or "eyes" begin to grow at the expense of the starch, the potato does not become mealy on being cooked, but has a semi-transparent aspect, and a sickly sweetish taste, and is no longer suitable for food. The effect of frost is equally injurious, though the deterioration is brought about in a different way. The effect of freezing is to a great extent of a mechanical kind. The albuminous fluid within the cells by the expansive action of frost disrupts them, and thus the organisation and life of the tuber is destroyed, and decomposition soon ensues.

When a good sound potato is boiled in water, the albumen of the liquor contained in and around the cells is coagulated, and the starch grains absorb the watery portion, and swell up and distend the cells in which they are contained. The coagulated albumen forms a sort of irregular fibrous envelope of the isolated, swollen starch grains, and the potatoes become "mealy." If these changes are only partially effected, the potato is watery, doughy, or waxy; and this is more or less the effect of the potato disease, when certain portions at least of the tuber remain hard and waxy after boiling. Potatoes are generally considered more palatable when boiled, so as still to retain their form; but there can be no doubt that they are more easily digested when boiled long enough to break down and be easily mashed. In like manner new potatoes, being less mealy, are less easily digested. Steaming appears to be a preferable process of cooking to boiling, and when the latter method is adopted, the skin should not be previously removed, as this serves to retain material that would otherwise be lost.



GRANULES OF POTATO STARCH IN THE HEXAGONAL CELLS OF CELLULOSE.*
(Magnified.)

That the potato is a wholesome, palatable, and popular article of food of considerable nutritive value is on all hands admitted. But considerable difference of opinion has obtained as to how far it of itself is capable of sustaining life and vigour for any length of time. Some experiments made by the Inspectors of Prisons in 1840 showed that young men and boys engaged in light work in the Glasgow Prison maintained their health and strength, and for the most part gained considerably in weight, on a diet consisting only of boiled potatoes, of which they were allowed 2lbs. (cooked) for breakfast, 3lbs. for dinner, and 1lb. for supper, and the prisoners expressed themselves satisfied with the diet. Other experiments made at the same time appeared to show that baked potatoes are less nourishing than boiled ones. If, however, any doubt be entertained respecting these and similar experiments, there can be no doubt that when potatoes are supplemented by some other food containing but a moderate extra amount of nitrogenous material, large classes of hard-working peasantry find in such a diet all they need for health and strength. Thus butter-milk, containing a certain amount of caseine, or fish, or a small portion of meat, provides with potatoes a sufficient and wholesome diet for working men.

The anti-scorbutic properties of the potato have been abundantly demonstrated by observation and experience. In prisons, and on sea-going ships, especially such as have been engaged in Arctic voyages, the potato has been proved to be the best preventive of scurvy. This valuable property is due to the various salts which the potato possesses, especially the citrate of potash.

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* The meshes of fibrous tissue, termed cellulose or cellular tissue, by which the starch grains are held together, are arranged in the form of hexagonal cells.

But valuable and wholesome as we have thus shown the potato to be, it is no less true that many dyspeptics and persons of weak stomach find it objectionable, and there is scarcely any common article of food which the physician more often finds it necessary to withhold from his patients. This arises chiefly from the large amount of starch which it contains. This also is the reason why it is so largely employed for the manufacture of starch and farinaceous foods consisting mainly of starch. There are various preparations sold under different names, the main constituent of which is the cheaply-provided potato starch. Potato flour, English arrowroot, and various children's foods, all consisting principally of potato starch, are of far less nutritive value than they are represented to be, and many of them are most undesirable for children's food.

There are numerous articles of an herbaceous character, which commonly are termed *green vegetables*, and which, though containing very little nutriment, are useful additions to our common diet. They contribute often in important ways to our health, form a very agreeable diversity to our food, and give a relish to other articles of greater nutritive value. They consist of leaves, buds, young shoots, leaf stalks, and sometimes of the whole plant. Certain of these, in some cases of disease, have an especial value. But with many persons of feeble digestive power green vegetables disagree, from their tendency to produce acidity and flatulence. The green colour of the leafy parts of vegetables depends on the presence of a substance termed "chlorophyll," which exists in the form of minute green globules, having characters intermediate between those of resin and fat. Light is necessary to the formation of chlorophyll, which is consequently prevented by growing plants in the dark, when they become white, or etiolated, as the term is. In this way the leaves and stalks of celery and sea-kale are rendered white. Nor is this all. When growing slowly in the open air, freely exposed to light, the formation of woody fibre is favoured, and the plant becomes proportionately hard and dry, and the specific principles of each plant are fully developed, giving them their respective flavour and smell. The object of cultivation is to render the plant succulent and tender, and in most instances to diminish or destroy those peculiar characters which render some vegetables bitter or otherwise disagreeable. It seems to be owing to the indigestible character of the green and woody constituents of vegetables that they prove more or less laxative in their action.

The *cabbage* tribe affords us many of our most common vegetable foods, such as the common white and red cabbage, the savoy, cauliflower, and broccoli. All these contain so large a proportion of water that by drying they lose 90 per cent. of their weight. The remainder is remarkably rich in nitrogen and sulphur, and consequently of high nutritive value. According to Boussingault 83 parts of dried white cabbage, or 810 parts fresh undried, are equal in nutritive value to 100 parts of wheat flour. It is owing to the presence of sulphur and the ready production of sulphuretted hydrogen gas, as well as of ammonia, that we have the disagreeable smell connected with the cooking of cabbage, and the still more disagreeable effects when they occasion, as they are so apt to do, flatulent indigestion

The *cauliflower* and the *broccoli* are the most delicate and highly-prized vegetables of this cabbage tribe.

The *Sauer Kraut* of the Germans consists of cabbage cut into slices packed with alternate layers of salt in a vat, and submitted to pressure for a sufficient length of time to admit of its passing through the process of acetous fermentation. It is then stewed in its own liquor, and eaten with bacon or other fat meat. It requires a highly educated stomach for its digestion, and few Englishmen can endure it. But as an anti-scorbutic it has a considerable reputation, and was well spoken of in this respect by Captain Cook.

Rhubarb leaf stalks, derived from several varieties of the genus *Rheum*, and *sorrel* from the *Rumex*, both of the buckwheat tribe, are characterised by the presence of oxalates and tartrates of potash and lime, and should be avoided by persons showing a tendency to the formation of oxalates in the urine, and are to some others objectionable, from the amount of vegetable acids which they contain. This is especially the case with sorrel, which is much used by the French under the name of "oseille," and which has a decided bitter as well as acidulous taste.

Spinach, which has analogous characters, is a more generally acceptable and wholesome vegetable with us. Both this and rhubarb are pleasant, cooling vegetables, and though they have a laxative tendency can be taken in moderation by most persons with advantage.

Sea-Kale, a marine plant improved by cultivation, and the *Artichoke* and *Asparagus* are among the most delicate and esteemed of our culinary vegetables, and are all wholesome and generally acceptable. The asparagus has a certain diuretic action, and gives a disagreeable odour to the urine, from the presence of a peculiar principle termed "asparagine."

There are a great many vegetables of no particular virtue, which in different countries are eaten as salads. With us the principal of these are *mustard and cress*, *water-cress*, *endive*, and *lettuce*. Some of these owe their pungency to a volatile oil, analogous to that which resides in the horse-radish. The most useful and wholesome, as well as the most popular, of all these is the garden lettuce, *Lactuca Sativa.*

The *Onion*, *Garlic*, *Leek*, and *Shalot*, members of the lily tribe, are chiefly used as condiments for flavouring. They all possess an acrid, stimulating, volatile oil, to which they owe their peculiar odour and flavour. And it is this which, being readily absorbed, passes out of the body with the various excretions and gives the offensive odour to the breath, in which garlic may sometimes be detected some days after it has been eaten. By long boiling, however, this volatile principle may be dissipated, and thus the large Spanish onion may be rendered agreeable as a vegetable either stewed or roasted, and is both nutritious and fairly digestible as well as sapid.

Similar remarks might apply to *Celery* (*Apium graveolens*), the odour and flavour of which, however, are much more delicate; but in the raw state even the best and most tender specimens are undoubtedly among the most indigestible of vegetables. This, however, is less the case when boiled or stewed, or as a constituent of soups.

There are several kinds of *Sea-weeds* which are used both as food and medicinally. Some of them, from containing iodine, are useful in scrofulous affections, and *Carrageen*, or *Irish Moss* (*Chondrus Crispus*), containing much mucilaginous and starch material, has long been employed in consumptive cases.

There are a few cucurbitaceous fruits which are used as vegetables rather than as fruits, but they are of very little nutritive value. The *vegetable-marrow*, when boiled, is an agreeable and wholesome vegetable; but the *cucumber*, even when boiled, is apt to derange the bowels, and when raw, even with the aid of condiments such as pepper and vinegar, is a most indigestible article and a fruitful source of bowel complaint. Despite of this, its cool agreeable flavour has given it a great popularity. The more rapidly it has been grown, and the fresher it is eaten, the less objectionable is it. When boiled it becomes more digestible, but loses its characteristic flavour.

Fungi.—These are among the lowest forms of vegetable life, and yet from the large amount of nitrogenous matter which they contain, approximate in their character as food to animal substances. They are largely consumed on the continent, and attempts have recently been made to bring them into more general use in this country by introducing various species which have hitherto not been considered eligible or safe. There has been a very general prejudice amongst us to all species, and these only can be said to be accepted as safe eating—viz., mushrooms, morels, and truffles. Nor is this prejudice without foundation. In the first place, it is generally admitted that whatever may be their nutritive value they are not readily digested, and are very apt in various ways to disagree with many persons; and in the next place the difficulty of distinguishing between the edible and the non-edible, or poisonous, is great, except by persons well acquainted with the respective characters of the different species. In the absence of this practical knowledge, the only safe rule is to restrict their use to those varieties which are well known and which have the peculiar aroma, taste, and aspect of the common mushroom, or *Agaricus Campestris.* Dr. Christison says that a sure test, indicative of a poisonous fungus, is an astringent styptic taste and a disagreeable pungent odour. Most fungi that have a warty cap, and especially if fragments of membrane are seen adhering to their upper surface, are poisonous. The poisonous fungi appear to possess a peculiar active principle to which the name of "muscarin" has been given, from the *Agaricus Muscarius,* in which it was first discovered.

In France, Germany, Italy, Russia, and other countries, fungi form an important article of diet. In the Pyrenees they are largely consumed by travellers as well as by natives, especially the Cêpe, a species of Boletus, and there can be no doubt that there are very many fungi available in England which are avoided, from the fears or predjudices already mentioned. Mushrooms, morels, and truffles are used by us chiefly for flavouring made dishes, as pickles, or for making ketchup. The truffle is a subterranean fungus, never appearing above the surface. There are several varieties, the most esteemed being obtained from the forests of Perigord.

The epicure prizes them for their peculiar flavour, but their dense, tough, cork-like texture renders them very indigestible. The common mushroom, either boiled, baked, or stewed, may be taken in moderate quantity by most persons without injury, but is certainly not adapted for those of weak digestion. As an addition to starchy and other foods deficient in nitrogen, it would seem desirable that the more wholesome varieties of fungi should be eaten by the poorer classes, by whom they may often be easily obtained.

FRUITS.

Under this head we have only to speak of such fruits as are used chiefly as dessert, for much of the food of which we have already spoken was derived from seeds, *i.e.*, fruits. Those of which we now treat come under the common denomination of fleshy fruits, consisting principally of a succulent external portion, containing a variety of principles giving them their special characteristics, with, generally speaking, little nutritive material.

Drupaceous, or Stone Fruits, called by botanists *Drupes*, contain one or more seeds proper, commonly called kernels, surrounded by a bony envelope called the stone (endocarp), on the outside of which is the soft fleshy portion (sarcocarp), which again is covered by a membranous skin (epicarp). The most common fruits of this class used in this country are of the almond tribe, such as the peach, nectarine, apricot, plum, and cherry. The difference in all these as regards their composition and edible qualities, and between the same fruit in its ripe and unripe state, depends on the chemical changes that take place during the process of ripening. In their green or unripe state they are all very much alike, and quite unfit for food. As the ripening process advances they cease to grow, and absorb carbon from the air and give out oxygen; the acids and astringent matter which they contain to a great extent disappear; the starch is converted into sugar; and the peculiar principles are developed that give the fruit its specific character. When over-ripe still further changes have taken place, occasioning loss of flavour, with disappearance of the sugar and other principles; and, finally, complete disorganisation sets in, by which the stone is set free and eventually broken up by the force of germination of the new plant. The larger the amount of soluble pulpy material, with a due proportion of sugar and gum to cover the free acid, of which there is always more or less present, the finer the fruit, provided its own specific flavour is well developed. The difference in these respects between the wild and the cultivated fruits is great, as is seen when comparing the wild sloe and crab with an Orleans plum and a Ribstone pippin. The object of the gardener is to develop the edible qualities at the expense of the sour and astringent hard sarcocarp of the wild tree. Well-ripened cultivated fruits of this class constitute an agreeable, refreshing food, digestible and wholesome, when taken in moderate quantity, and of a value that is not to be estimated by their comparatively small amount of nutritious material; but they all have a more or less laxative action and tendency to excite intestinal irritation in the susceptible, and in certain constitutions they are scarcely admissible. There is, however, much reason to doubt whether they are as objectionable as has often been represented in gouty habits of body. The vegetable salts which they contain are certainly advantageous in many such cases, and their general antiscorbutic qualities are unquestionable. Most of these drupaceous fruits are now imported in large quantities in a dry state, and are very acceptable additions to the dessert. Of plums there are two principal kinds thus introduced. The finer French prune, which has been dried in the sun, when newly brought to market and not too dry, may be taken in moderate quantity with advantage, whilst the smaller variety, of a coarser character, and sometimes called the medicinal prune, when stewed and eaten with plain boiled rice, makes a wholesome and useful sweet dish.

The *Date* (*Phœnix dactylifera*) is a drupaceous fruit of the utmost importance in the East, where it forms the main sustenance of Arabs and others. Sugar appears to be its main alimentary constituent.

Pomaceous Fruits.—The apple tribe affords several fruits which are extensively used and of considerable value as additions to diet tables. The edible portion is here again the fleshy mass or sarcocarp, which, however, is for the most part of a much firmer texture than in drupaceous fruits when ripe, and the core, or endocarp, which encloses the seeds, is a dense membrane, instead of being stony. The apple and the quince, even in their fully mature or ripe state, have a solid, firm texture, but most of the pears become more or less soft. They are, therefore, more digestible than apples, which can only be indulged in by persons of tolerably good digestive powers, and then only in small quantities. Nevertheless, as articles of food apples are more valuable than pears. When cooked, and thus made thoroughly soft, they are rendered much easier of digestion; and, as they admit of being dried and compressed, they can be kept for a long time without undergoing any change, and when stewed can be brought again into a digestible state. Both pears and apples are considered slightly relaxing, especially the latter, and for this purpose they are often taken with coarse brown sugar, which, while covering the acidity and acerbity of the coarser varieties, increases their laxative action. The vegetable acids which they contain render them both palatable and wholesome constituents for puddings and pies, and the more valuable because they are available when other fruits are not to be obtained. From the fermented juice of the apple cider is made, and from that of pears perry. Both these beverages are apt to disagree with those who are unaccustomed to them, although the choicer specimens are cooling and refreshing drinks in hot weather.

Berries, or Baccate Fruits.—To these belong the currant, gooseberry, cranberry, elderberry, and the grape. In these the seeds are embedded in the semi-fluid pulp, or juice, which is surrounded by a more or less dense and firm pericarp, the skin or husk. Both this and the seeds are very indigestible, and should not be swallowed—the latter especially are a fruitful source of bowel irritation. When unripe they are all exceedingly tart, and still more readily excite bowel disturbance with much griping. When ripe, both the red and the white *Currants*, from the amount of agreeable acidulous juice which they contain, along with a certain amount of sugar, form excellent material for sweet dishes and for jellies and syrups. The black currant has a special volatile principle, giving it its peculiar flavour, and a purple colouring matter of considerable intensity. It has also a thicker, very indigestible skin. The *Gooseberry* in its general character resembles the currant. But through cultivation we have numerous varieties of these, some of which are more wholesome and greatly preferable to others. The flavour of those which are grown in northern climates—as in Scotland—is generally thought superior to that of the fruit produced in warmer regions. It is, indeed, a fruit of cold climates. The *Cranberry*, which is also a native of northern climes, contains a large amount of vegetable acid, and is therefore unfit for eating in the raw state. It is largely imported from Russia and America, and is generally esteemed a pleasant and wholesome constituent for pies and puddings. The *Elderberry* is principally used for making elder wine, an old-fashioned remedy for colds and feverish states.

The *Grape* demands more special notice, not only from its historic and universal reputation, but also from its real value and the various and important uses to which it is applied. From time immemorial it has been cultivated and held in the highest esteem. It has been the theme of the poet in all ages, and the source of wealth in all countries admitting of its cultivation. In this place, however, we speak of it only as a fruit, although, from its being the source whence all the numerous varieties of wine are obtained, the grape vine has been denominated *Vitis vinifera.*

The juice of ripe grapes, according to Proust and Berard, contains a large amount of grape sugar, a small quantity of glutinous material, bitartrate of potash, tartrate of lime, malic acid, and some other things of less importance, dissolved in water. The amount of these several ingredients varies in different kinds of grapes. These are very numerous, and the form, size, and colour of the berry are very various. No less than 1,500 varieties are described in works on viniculture.

The grape being a native of hot climates, and requiring not only a considerable amount of sun and heat for its due ripening, but also a particular character of soil, it cannot be cultivated to any extent in this country, except under glass. But the finest grapes that are grown for the table are those of our hot-houses, as the result of careful cultivation and long experience and skill. In its native lands, the grape is largely consumed as an article of food. It is undoubtedly one of the most agreeable, wholesome, and nutritious of fruits; refreshing and cooling, it may almost always be safely taken by invalids. Grapes should be taken without their husks and seeds, which are indigestible and liable to induce bowel-irritation. The juice or pulp has a diuretic and slightly laxative action. In certain forms of dyspepsia and in consumptive cases, they are extensively used, and in Switzerland and some other places constitute what is called the "Cure de Raisins."

When dried, grapes are called by us raisins, after the French name for the fruit. In this state they contain more sugar and less acid, and are less digestible, though not less nutritious. There are various ways of drying grapes for commerce, such as by simple exposure to the sun, by steeping them in hot water, and by various other manipulations. Thus we have Muscatels, Valentias, Blooms, Smyrnas, &c. Two of the most extensively used are termed Sultanas and Currants. The former is a small white grape, devoid of stones, and on this account prized in the kitchen; the latter is a small black grape, which, being originally imported from Corinth, came eventually to be called "currant," and thus, by many people, it is even now thought to be a currant, and not a grape. These small black raisins enter into the composition of the Englishman's plum-pudding of world-wide reputation, along with other not very digestible things, which go to form that famous Christmas compound. Where they do not occasion any manifest inconvenience, the skins often pass through the bowels undigested, particularly in the case of children. In the finer varieties of raisins taken at dessert, the skin is thinner and more delicate, and thus less objectionable. Like dates, raisins being very nutritious, and to most persons even more palatable from their pleasant acidulous character, form with bread or biscuit a very good and conveniently carried diet for travellers and sportsmen.

There are a variety of fruits which do not fall under either of the classes of which we have spoken, but which are of value in various ways. In our own country, strawberries, raspberries, mulberries, bilberries, and even blackberries, afford agreeably refreshing juices, though devoid of any great nutritive value; and some make excellent preserves. The common fig, which is a native of Asia, but which is extensively grown in Spain, Italy, and the south of France, is in many places an important part of the food of the people, both in the fresh and dry state. It consists of a pulpy pear-shaped receptacle, in which are embedded numerous seed-like bodies. When unripe, they contain an acid bitter juice, which in the ripe state is replaced by sugar, and as cultivated and ripened in hot countries are then a luscious, rich fruit of great nutritive value, from the large amount of saccharine matter which they contain. There are many varieties cultivated, of both green and black figs, some more delicate in flavour than others. Fresh figs are not very generally appreciated with us, though great favourites with those who have made acquaintance with them in southern climes. Even in the fresh state, they are slightly aperient, and still more so in the dry state.

The *Plantain* and the *Banana* are both products of the genus *Musa*. The former is said to have received its specific name, *Paradisiaca*, from being imagined to have been the fruit which tempted Eve in Paradise, whilst the banana (*M. Sapientium*), was so called from being the chief food of the Brahmins, or wise men of the East. Both these fruits, which constitute the chief sustenance in many districts of the East, are among the most important articles of food. The fruit grows in large bunches or clusters, weighing sometimes as much as forty or fifty pounds. The outer portion or integument is thick, and readily stripped off, exposing a soft spongy core, rich in saccharine and nutritious matter. In the unripe state, before the full development of the sugar, the core is rich in farinaceous matter, and when dried and ground constitutes what is called plantain-meal, which is extensively used in British Guiana for children and invalids' food. It is both easily digested and nutritious. Of late years the fruit has been largely imported into this country, and is now very often seen at dessert. It has a peculiar flavour, which renders it sickly to many people, whilst others consider it a luscious, palatable fruit.

The *Bread Fruit* of the Polynesian islands is obtained from a species of Artocarpus, the fruit sometimes attaining to the size of a small loaf. It takes the place of our wheat among the islanders of the Pacific as their chief food.

The *Melon*, which is one of the gourd tribe, from the amount of cool, refreshing juice which it supplies, is a delicious, acceptable fruit in hot countries and seasons, and has led to its careful cultivation, and the introduction of numerous species, which differ in size, form, character of the rind, and colour of the flesh or pulp, which may be either green, red, or yellow. The water-melon is now imported in great numbers, and as it will keep for a length of time is available when other fruits are scarce. Like all other members of the gourd tribe, the melon is apt to disturb the bowels.

The *Pineapple,* one of the most delicious fruits of the West Indies, and brought to highest perfection in our hothouses, is eaten at dessert as a delicacy in small quantities, and is a good deal used for flavouring, and as a preserve.

The *Aurantiaceæ,* or orange tribe, affords us some of our most popular and useful fruits. The orange, lemon, citron, lime, shaddock, and pomelo are all derived from species of the genus *Citrus.* There are certain characters and properties which are common to all of them. They have a leathery thick rind, which contains a volatile oil, lodged in small vesicular receptacles, and the acid juice is contained in a pulp separated into distinct compartments. The juice abounds in vegetable acids, with varying amounts of sugar, mucilage, and distinctive aromatic principles, giving to them their respective flavours. The proportions of the acids and salts, and amount of mucilage and sugar, vary in the several species and varieties. By virtue of their acidulous juices, they are valuable as antiscorbutics, and for the preparation of acidulous drinks. Of all this tribe the common, or sweet orange, is the most agreeable and useful as a fruit. It is, in fact, one of the most grateful and refreshing, and when thoroughly ripe and sweet, the most unobjectionable, even to delicate stomachs, provided the seeds and pulp, after being sucked, are rejected. Unless we except the grape, there is no fruit so useful in sickness, and so little likely to disorder the bowels, whether in childhood or old age. The aromatic bitterness of the Seville or bitter-orange rind is made available in the form of marmalade, wine, and tincture, as a useful stomachic; and the corresponding principle in the lemon is largely used for flavouring purposes.

Farinaceous Foods.

When enumerating the non-nitrogenous alimentary principles we had to mention starch and sugar in the Carbo-hydrate group as very widely distributed in the vegetable kingdom, and as constituting the chief force-producing agents. From various plants these principles are obtainable in large quantity, for the sake of which they are cultivated. The chief of these require separate mention.

The farinaceous, starchy, or amylaceous foods obtained from sources which have not already been mentioned are sago, tapioca, arrowroot, tous les mois, and salep.

Sago is obtained from the central part or pith of the stems of various species of palm, which, after being extracted, is reduced to powder, mixed with water, and strained through a sieve. From a single tree it is said that several hundred pounds may be obtained. Several kinds of sago are in the market. Simple sago flour is the dry and powdered extract that has passed through the sieve. Granulated sago, or pearl sago, is the sago powder made into a paste with water, and then granulated.

It then consists of small pinkish grains about the size of a pin's head. Common or brown sago occurs in larger grains of a brownish colour. Those specimens of sago, which are most devoid of colour, are the best. There are fictitious sagos sold which are made from potato starch, but this may be detected by the microscope. In many eastern countries sago is an important article of diet. It is easy of digestion, and to a certain extent nutritive. It has but little flavour, and is used by us as an ingredient of soups, puddings, and invalids' food. The grains, though absorbing the liquid in which they are cooked, retain their form. When boiled in milk, till the sago is thoroughly incorporated, it makes a light, nutritious, non-irritating food.

Tapioca and *Cassava*, or *Manioc Flour*, are derived from more than one species of the poisonous tribe *Euphorbiacœ*, which abound in an acrid, milky juice. The tuberous roots of the manihot, or jatropha, are scraped, reduced to a pulp, and then dried on hot plates; by this means the juices are got rid of and the poisonous principle destroyed by the heat. Tapioca is brought to this country in the form of irregular small lumps, which, on being boiled, become a gelatinous, tremulous mass. In nutritious qualities it agrees with sago, and is used for much the same purposes. It has a slight and somewhat sickly flavour. In the opinion of Dr. Christison, no farinaceous substance is so much relished by infants about the time of weaning, and in them is less apt to become sour during digestion than any other farinaceous food, not excepting even arrowroot. Being more soluble than sago, it requires less time for maceration and boiling.

Arrowroot (or West Indian arrowroot, as the best kind is called) is a pure white farinaceous article, derived from the tubers of the *Maranta Arundinacea.* Its specific name was given to it from the belief of the Indians that the plant was an antidote to the poison of the arrows of their enemies. It is prepared much in the same way as tapioca, and, when cooked, makes a tolerably strong jelly, free from any colouring matter, or any particular odour or flavour. Consisting, as it does, of almost pure starch, it has scarcely any sustaining power, though it is easily digested and non-irritant; it is, therefore, unsuitable for the main food of infants unless combined with milk or other nutritive material. There are, moreover, various fictitious arrowroot powders sold which are chiefly made of potato starch. *Tous les mois* is also obtained from the tubers of a West Indian plant, the *Canna Edulis.* *Salep* is prepared from the roots of several species of orchids, natives of Persia, Turkey, and India.

SACCHARINE SUBSTANCES.

From time immemorial these have been employed as food, and in the present day they are among the most important commercial articles, from their almost universal use, both as food and as luxuries. In the ancient world the principal sweets were the honey, grape, manna, and fruit sugars. Cane, maple, beet, maize, and palm sugars are comparatively modern. All these, and some other saccharine substances, differ more or less from each other in their composition, solubility, crystallisability, and susceptibility of passing into the process of fermentation. The sugar consumed in Great Britain is chiefly derived from the sugar-cane and from beetroot, and is estimated to amount to nearly 40 lbs. per head of the population. Probably there is no one element of food the loss of which would be more seriously felt.

The principal sugars are divisible into *Cane* and *Grape Sugars*, and are so termed from the former being chiefly derived from the sugar-cane and the latter from grapes. Some sugars are crystallisable, whilst others are not. The juice, which is obtained from crushing the sugar-cane, contains about 20 per cent. of sugar mixed with various impurities. This is first clarified, evaporated in pans, and set aside, when the uncrystallisable portion is drained off as molasses and the coarsely crystallised portion collected. This constitutes what is termed raw sugar, and is exported in barrels to this country, still mixed with impurity, and rendering a further process of refining necessary. Other varieties of cane sugar known in commerce are derived by processes more or less similar from beetroot, the palm or date, the maple, and maize. The cultivation of beet for the purpose of sugar-making is of very recent date. As a part of the policy which led the first Napoleon to exclude from France articles of foreign, and especially British, production, he forced on the French the cultivation of the beet and the manufacture of sugar from the roots. Since then a large and successful manufacture of beetroot sugar has been carried on in France and other European countries. Attempts to utilise the plant for the same purpose in this country have not been successful. In North America a species of maple, the *Acer saccharinnia*, is made available for obtaining sugar by incising the bark and allowing the sap to exude.

Grape Sugar, sometimes called glucose, includes several varieties, obtained from grapes, honey, and various fruits and starches, especially potato starch. The constitution of these differs somewhat from that of cane sugars; they crystallise very imperfectly, and are less sweet. They cannot be said to be of any dietetic value, but are understood to be employed to adulterate the cane sugars of commerce. The best illustration of the whole class may be examined any day in a good raisin that has been kept some time, which, when opened, is found to contain a number of small granules of imperfectly crystallised sugar. We have alluded to the well-known change that takes place in fruits when passing from the unripe to the ripe state in the production of sugar. All plants or fruits that possess acid or sour juices yield grape sugar, the changes taking place in the growth of the plant or fruit determining those chemical actions by which ordinary cane sugar becomes converted into grape sugar or glucose. The sugar-cane and other plants yielding cane sugar possess, for the most part, very little acid in their sap.

That sugar conduces to fat production is a common notion which has a sound philosophical foundation. It also contributes in other ways to the sustenance of the frame. Being very soluble it requires no preliminary digestion to fit it for being absorbed. In some cases, however, it appears very readily to pass into the acid fermentation, and so give rise to indigestion, characterised by acidity and flatulence.

The injurious effects often ascribed to it have but little foundation. Children, for the most part, take it readily, and appear to have a natural instinct for it, as might be inferred from its presence as a constituent of their earliest food—milk. In reference to the common notion that it spoils the teeth, Dr. Wright says, "that this is a mistake is sufficiently proved by the fact that no people have finer teeth than the negroes, who feed largely on it. Its nutritious value cannot, however, be inferred from the same sort of evidence. For the juice of the sugar-cane, which the negroes suck to a great extent, differs from pure sugar, inasmuch as it contains gluten as well as other alimentary principles." This mode of using the sugar-cane appears to have prevailed before it was employed for the extraction of sugar in a separate state. The Latin poet, Lucan, speaks of the eaters of the cane as—

> "Quique bibunt tenerâ dulces ab arundine succos."

Honey Sugars, or *Honeys,* are extracted by bees from the nectaries of flowers. They deposit it in their crop or honey-bag, whence they emit it when they return to the hive. It is assumed that, by the action of the secretions of the insect's crop, some change is effected, so that the honey we get from the hive may not have the same chemical constitution as it had when gathered from the flowers; but that it has specific characters derived from the particular plant there can be no doubt. For honey is a solution of sugar mixed with odorous and other peculiar principles, colouring gummy and waxy material. When honey is allowed to stand, it gradually thickens and consolidates, and by pressure in a linen bag it may thus be separated into a white solid sugar, consisting of minute crystals and a thick semi-fluid syrup, which passes through the bag. Both the solid and liquid sugars have the same general properties. The liquid, however, crystallises but sparingly, and contains an admixture of colouring and odoriferous substances derived from the flowers. It is to these foreign materials that the honey owes its special flavour and odour, and also its occasional poisonous action. Hence, too, the special reputation and value attached to honey from particular localities—to that from Hybla in Sicily, and Hymettus near Athens, by the Greeks; and to that from Narbonne, Chamounix, and other places, by the moderns. On the other hand, the honey brought from Trebizonde on the Black Sea has been noted from the time of Xenophon as deleterious. This is ascribed to the flowers of a species of Rhododendron—*Azalea Pontica*—from which the honey is partially extracted. The poisonous action of this honey is thus described by Xenophon in his "Retreat of the Ten Thousand." "And there was there (in a village near Trebizond) a number of bee-hives; and as many of the soldiers as ate of the honeycombs became senseless, and were seized with vomiting and diarrhœa; and not one of them could stand erect. Those who had swallowed but little looked very like drunken men, those who ate much were like madmen, and some lay as if they were dying. And thus they lay in such numbers, as on a field of battle after a defeat. And the consternation was great. Yet no one was found to have died: all recovered their senses about the same hour on the following day. And on the third or fourth day thereafter they rose up as if they had suffered from the drinking of poison."

Water.

From what has been said of the composition of the various alimentary substances, it will have been seen how large a proportion of water exists in all, whether of animal or vegetable origin. Few persons, probably, are aware how large a part of the human body is water: of the solid, or fleshy portions, 75 per cent., of the blood 80 per cent. By evaporation, and by the different processes of secretion and exhalation, this is being constantly dissipated, so that it is evident there must be need of constant fresh supplies. But for the performance of all the vital processes of the higher classes of living organisms water is required, is even more essential than solid food, and only less essential than air. For digestion, and the various chemical transformations which our food undergoes in order to keep up the structure of our frame, water is essential. The actual amount of daily supply needed varies with the amount of exercise and the temperature to which the body is exposed, and it is by the cooling effects of evaporation by the skin and lungs that the temperature of the body is kept within proper limits. The amount of fluid lost during active exercise in heated atmospheres may be judged of by what occurs in the case of engine-stokers, miners, and glass-blowers. Cornish miners, working at great depths in a high temperature, have been known to lose as much as five pounds in weight in the course of eight hours' work. The sensation of thirst may be said to be the natural index as to the amount of fluid required by the system. But there is great difference in the amount taken and required by different individuals, apart from all consideration as to the nature of their food. These, however, are points that will require consideration in a future place.

The importance of water in the whole economy of nature can scarcely be exaggerated, and as it constitutes the basis of all our drinks it is essential that we should obtain it in abundance and in as pure a state as possible. In *rain water* and *distilled water* we have it supplied of the purest quality. The evaporation which is constantly going on from the surface of the earth is a natural distillation of water, which, ascending into the atmosphere as vapour, becomes condensed and falls as rain. When collected with due care in the open country it is practically free from all impurity, containing merely a certain amount of ammonia combined with the air, by which the rain is aerated; but when collected in the neighbourhood of towns and manufactories it becomes impregnated with various organic and other matters contained in the smoke. Distilled water is absolutely pure, but less palatable, from the absence of salts, and not being aerated. By means of distillation our ships are now enabled to supply themselves with pure fresh water from the sea. The chief precaution that is necessary in storing and using pure distilled water is, that it should not be kept in contact with lead. The purer the water, the more dangerous is it to keep it in leaden cisterns, or transmit it through leaden pipes. Leaden cisterns, open to the air, are dangerous, even when the water is not pure, in consequence of the measure of evaporation or natural distillation that goes on from the surface, as the water, after rising and becoming condensed, falls down again and comes in contact with the lead. The water thus becomes charged with salts of lead that exert a highly injurious action on the system, characterised by symptoms known as those of lead poisoning.

Our common drinking water is derived either from springs, wells, or rivers. All are, in fact, rain water, which has percolated through rocks and soil; but there are important differences between them. Spring water is charged with gaseous and saline matters derived from the soil through which it has passed, and it may be also with organic matter, if not taken from its immediate source. There is, consequently, great diversity in the quality of spring water, as will be at once evident if we look at the numerous mineral waters in use for medicinal purposes. Many springs, however, afford us the purest and most refreshing water—especially those which gush from chalk and limestone rocks charged with carbonic acid and carbonates. Well water, or pump water, is the same as spring water, the well being simply the means of retaining the water and preserving it for use. The deeper the spring whence the water is obtained, the purer generally is it. But unless the well or reservoir be protected from soakage through the adjacent soil, its contents may be rendered unfit for drinking purposes. Inattention to this has proved the fertile source of innumerable calamities. Shallow wells obtaining their supply from superficial sources may afford a bright, sparkling water, pure and pleasant to the taste, and yet containing the seeds of fatal disease. The vicinity of sewers, cesspools, and, what is still more disgusting, of graveyards, may be the means of contaminating a well with decomposing organic matters, animal exuvia, and microscopic germs engendering some of the most fatal diseases.

River water is, of course, more or less impregnated with decomposing organic material, as well as with the various saline and mineral constituents of the soil washed into the rivers. They are also contaminated, not only by the refuse of cities and towns, but also by the different specific deleterious waste from chemical and other manufactories. This often occurs to such an extent as to kill all fish in the river; but except in such special cases, the amount of foreign matters is reduced to a minimum by dilution and the continual flow of the stream, and also, it is considered, by the oxygenating effect of vegetable life, and from exposure to the air. Some of the purest water is obtained from some of the lochs of Sweden and Norway, and from granitic districts, which are practically free from organic material, and contain not more than from five to ten grains of saline matter to the gallon. Some rivers contain from 30 to 40 or 50 grains in the gallon. The most impure and dangerous water is that which comes from marshy districts, and from stagnant pools. Carbonates and sulphates of lime and magnesia are among the chief saline matters in waters otherwise pure, and when these are in excess the water is said to be hard, curdling soap, and unfit for washing, though not necessarily for drinking purposes. The purest waters are always soft. When any amount of nitrates are present, it is a sign of contamination by animal or other organic matters; and when saline matters in great excess are present, the water may be unsuited for particular constitutions, though not otherwise objectionable.

No pains should be spared in order to be sure that the water drunk is wholesome and practically pure. Foul tanks are a very common source of bad and unwholesome water. They should always be carefully covered and protected from all extraneous defilement, and should be scrupulously cleaned at short intervals, especially after heavy rains. There is no more reprehensible practice than the too common one of making the same cistern supply the water-closets and the water for drinking. It is almost impossible to completely prevent the passage of gases from the closet to the tank.

Fortunately there are two simple methods by which every household may render themselves secure: these are by boiling and by filtering the water used for drinking purposes. One of the effects of boiling may be seen at any time by examining the interior of a kettle or boiler that has been for some time in use, which will be found coated with what is called "fur," that is, saline matters that have been separated from the water and have formed a stony lining to the vessel. The heat of boiling water also destroys the vitality of any organic germs with which the water may be charged, and thus ensures protection from one of the most dangerous sources of disease.

By *filtration*, also, water may be deprived of living organisms and suspended impurities. This is, to a certain extent, done by the London water companies, by filtration through sand and gravel before the water is distributed. But by this means all sources of danger are not obviated. Percolation through animal charcoal, or porous iron, by means of the various filters that are now readily obtained, removes pretty completely all impurities, both organic and saline. But to render assurance doubly sure, the water should also be boiled. All filters require to be examined, cleansed, and to have the charcoal renewed from time to time. There are various aerated waters now in use, which are charged with carbonic acid, and which are wholesome and refreshing. Some of these are derived from natural sources, and contain certain salines in very small quantities; others are simply pure waters into which carbonic acid has been driven, and it is manifest are no safer drinks than other waters, unless care has been taken by the manufacturer to select from a pure source the water for his purpose.

Toast-and-water, made by pouring boiling water on toasted bread, is an agreeable and wholesome drink too much neglected in the present day. It should be used fresh, as soon as it has become quite cold.

TEA.

If milk and water, the two natural liquors, are the most universally employed of all drinks, tea stands next in popular use among us. At the present time it is estimated that it is consumed by one half of the human race. Coffee and cocoa stand next in order. It is remarkable that all these three articles of food contain a very similar if not identical principle. Theine and caffeine are, indeed, considered by chemists as absolutely identical principles. A similar principle is found in what is called Paraguay tea, and in Guarana tea, derived from different plants in South America and Paraguay. Tea, coffee, and cocoa are all of comparatively recent introduction into Europe, and though obtained from very different tribes of plants, they have alike come into general use, from having been found by experience to possess analogous dietetic virtues, which chemists have at length ascertained to be due to the existence of analogous chemical constituents. An interesting chapter might be written on the history of tea as a beverage and its influence on social customs, and even politics and international relations. The first coffee-house was opened in 1650, in St. Michael's Alley, Cornhill, and in 1660 coffee-houses were so numerous as to have been made a source of revenue by imposing a tax of 4d. a gallon on the coffee drunk in them. Chocolate was introduced by a Frenchman about the same time. Tea was introduced by Lords Ossery and Arlington in 1666, and was first sold at Garraway's coffee-house, Cornhill, where Defoe says ministers and foreign bankers resorted to drink it. In 1767 the duty on tea led to the riots in Boston and the outbreak of the American War of Independence. From the time when Shakespeare and Ben Johnson met at the "Grecian," coffee-houses where coffee, chocolate, and tea are drunk have been the resort of poets, wits, literary men, politicians, and merchants. In the 17th century tea was sold at ten guineas a pound, whilst good tea may now be obtained at 2s. a pound.

This leaf, of world-wide repute and consumption, is the produce of the genus *Thea*, of the same tribe as the well-known *Camellia Japonica.* It is questionable whether all the varieties of tea are not obtained from the same species. Mr. Fortune, who is the highest authority on the subject, informs us that black and green tea are both derived from the plants known as *Thea bohea*, *Thea viridis*, and *Thea sasunga*. These several varieties are all grown in different districts of China. But the tea plant is now extensively cultivated in British India, Ceylon, Java, and other countries. Its consumption in the United Kingdom was, in 1871, 3 lbs. 15 ozs. for each of the inhabitants, and the revenue derived from it forms an important item in the budget of to-day.

The finest tea consists of the first young leaf buds, which are strong in taste of the early juices of the plant. Later on in the year the chief gathering takes place, and a third gathering, when the plant is in a measure exhausted, affords an inferior quality. Green tea is prepared from the young leaves, which, soon after gathering, are roasted in pans and rolled by hand. The characteristic odour depends on the precise locality in which the plant is grown, and also on the careful drying or roasting of the leaf, by which its aromatic qualities are brought out. But the Chinese use various flowers of the rose, jasmine, and orange to give specific aromas. Lie tea is made from the dust and sweepings of the warehouse, cemented with rice, and rolled into masses. Brick tea is composed of the same materials, together with broken twigs, and moulded into forms. This is used by the Tartars, when reduced to powder, and mixed with fat and salt and roasted meal, as a solid food. The mode adopted by the Chinese in their use of tea is to put it in a cup, and having poured hot water on it, to drink the infusion from off the leaves, without any admixture. In this way they use it to quench thirst, as we should drink water. The Russians drink it with a squeeze of lemon, either with or without sugar. With us cream or milk, and generally sugar, are added.

There is considerable difference of opinion among medical men as to the physiological action and dietetic uses of tea. The effects, as used in China and described by Chinese writers, are thus given by Mr. Fortune: "Tea is of a cooling nature, and if drunk freely will produce exhaustion and lassitude. Country people, before drinking it, add ginger and salt to counteract this cooling property. It is an exceedingly useful plant. Drink it, and the animal spirits will be lively and clear. The chief rulers and nobility esteem it; the lower people, the poor and beggarly, will not be destitute of it. All use it daily and like it. . . . . Drinking it tends to clear away all impurities, drives off drowsiness, removes or prevents headaches, and is universally in high esteem." This last statement is daily receiving confirmation, as it is coming more and more into use in countries, as in France, where, till in recent years, it was little known or appreciated. But, before entering further into its action on the system and its dietetic merits, it will be desirable to examine its leading constituents. These are four: (1) Volatile Oil; (2) Theine; (3) Gluten; (4) Tannin.

(1) *Volatile Oil.*—By the distillation of the tea-leaf there passes over a volatile oil, having the aroma and flavour of the particular tea. To this, there seems no doubt, we must ascribe its narcotic and some other effects on the nervous system, such as headache, giddiness, tremors, and wakefulness. These effects are more marked in the case of green tea and fresh new tea, in which there is the largest amount of volatile oil.

(2) *Theine* is a crystalline substance rich in nitrogen. It has a slightly bitter taste, but no smell, and seems to have very little to do with the flavour of the tea. The proportion obtained from different varieties of tea varies, according to the different analyses that have been made by Stenhouse and others. The peculiar virtue possessed by it is considered to be its power of arresting or diminishing the waste that is constantly going on, and so to lessen the necessity for food to repair that waste. The health and strength are thus maintained by a smaller amount of food, and the tea, though not a true food, takes the place of it. But inasmuch as tea-leaves contain also a considerable amount of a third principle, viz.—

(3) *Gluten,* and as this, we have seen, is one of the most important nutritive principles of plants, it must be held to confer on tea a positive nutritious value. We, however, obtain very little of this principle when we take only the infusion of tea, as the greater part remains in the leaves, not being extracted by the water. By the addition of a little soda to the water in the teapot the gluten is extracted and the nutritive principle is obtained. The Tartars are said to accomplish this end by the water of the Steppes, which contains lime, and other peoples have by experience learnt the same fact, inasmuch as, after drinking the infusion, they eat the leaves.

(4) *Tannin, or Tannic Acid,* is a powerful astringent of which tea contains from 15 to 20 per cent. It is to this that its astringent effect on the bowels, as well as its bitter styptic taste, depend. It is mainly to this principle that we attribute the symptoms of indigestion that succeed to the use of strong tea that has been allowed to "brew"—that is, stand for a long time before being drunk.

The combined action of these several principles in the infusion as we ordinarily drink it is, no doubt, different from that of any one single constituent. In most cases the influence on both the nervous and vascular system is that of a soothing as well as exhilarating kind. But with many people the action on the brain is antagonistic to sleep, and they are kept awake if they take strong tea at night, although, its action on the skin being to promote perspiration, it tends to allay feverishness and exert a cooling influence.

Nearly all the kinds of tea in the market, provided they are genuine, closely approximate to each other in dietetic value, and there is no necessity to go to a high price in order to obtain good tea containing the full amount of the most important constituent, "theine," which should amount to 3 per cent. In this respect a genuine Congou at 2s. a pound is as good as the expensive Russian caravan tea, costing, perhaps, £2 2s. a pound. But the difference in flavour is great, and this must be paid for as a luxury. Ordinary good Congou has, however, sufficient flavour and body to satisfy most persons, provided it be properly prepared for drinking. For the sake of economy, therefore, this kind should always be preferred. For those who do not regard expense, it may be mixed with some of the choicer varieties, such as Souchong, Kaisow, or Orange-flavoured Pekoe. But connoisseurs prefer the natural flavour of a good unmixed tea, the leaf of which should be closely rolled and free from stalks.

COFFEE.

Coffee is the seed of the berry of the *Coffea Arabica* belonging to the order of plants which produce the Peruvian bark, a native of Arabia and Abyssinia, which is roasted, ground, and infused in boiling water to be used as a beverage like tea. Its leading constituent, "Caffeine," is identical with "Theine," and it contains also a similar volatile oil and astringent matter. Several varieties are imported, bearing the name of the country from which they are obtained. Arabian or Mocha coffee is a small dark yellow seed; that of the Malabar or East Indian is larger, and of a paler yellow; that from Ceylon, Jamaica, and the West Indies has a bluish or greenish grey tint. The quality and flavour of the beverage depend greatly on the manner of roasting the seed or bean, and the mode of making the infusion.

It is by roasting that the aroma of the fruit is brought out, and the coffee prepared for grinding. Previous to roasting it has but little smell, and only a bitter astringent taste, and as the amount of volatile oil on which the aroma depends is very much less than in tea, it is of importance to ensure the greatest possible development of this principle. It is believed that the bean ripens by keeping, so as to evolve a larger amount of the peculiar constituent from which the volatile oil is derived. But as it is by the action of heat, during the process of roasting, on this peculiar constituent that the aroma is elicited, great care and nicety are requisite in the roasting process. This is performed in an iron cylinder, made to revolve over a fire, which, on the Continent, is usually a charcoal fire. During this process the coffee passes from its native colour through various shades of brown, according to the extent to which the roasting is carried. If it be not carried sufficiently far, the aroma is not fully developed, and if too far it is partially destroyed, and a disagreeable flavour induced. After the roasting, the sooner it is ground and used the better the coffee. If not immediately used, it should be kept from the air in suitable canisters, and not in paper, or an open jar. When prepared for drinking, the beverage should be an infusion and not a decoction, as by boiling the aroma is dissipated. But as by infusion other constituents termed extractive matter, which comprises a nitrogenous nutritive material, are not obtained, but remain in the "grounds," it has been recommended as the best way of making coffee to boil the grounds of the previous infusion and strain off the boiling water from them, and then pour this over the fresh coffee in a suitable percolator. By this means both the aroma and all other useful ingredients of the coffee are obtained. The Arabs appear to have less regard for the aroma, as they make a decoction of the unroasted bean and consume this with the grounds. As we have stated in reference to tea, soft water extracts more from the coffee than hard water, and, therefore, it is recommended to add a little carbonate of soda to the water—about forty grains being sufficient for a pound of coffee. For the same reason the water of particular places improves the coffee which is made there.

The remarks already made on the action of theine on the system as a sustaining agent apply to caffeine; but as weight for weight tea is said to yield twice as much theine as ground coffee does, we use a greater weight of coffee than we do of tea for the preparation of the same quantity of beverage.

The valuable properties of coffee amply justify its widespread use and popularity. Like tea, it has an unquestionable invigorating, restorative, and sustaining power, but it is more stimulating and exciting to the nervous system, and in many people excites feverish action; for it does not excite perspiration like tea, but rather induces a dry and hot skin, increasing the force of the circulation. To this is probably to be attributed its so-called disinfecting property, or power against malarious influences. Travellers in the district of the River Plate and other malarious regions speak very positively of its powers in this respect, and state that since the natives in Guayaquil, in Ecuador, have substituted coffee for their former beverages, the death-rate in pestilential districts has fallen very considerably. With some, coffee proves decidedly laxative, but the reverse effect is more usual. It generally disposes to wakefulness, and in small quantities after a hearty meal with wine it counteracts the feeling of heaviness and oppression. As in the case of tea, there is great difference in individual constitutions in regard to its action both on the circulation and on the nervous system, some people experiencing, after a small cup of strong coffee, the most uncomfortable tremulousness and nervous excitement, and inability to sleep. When taken for breakfast, with a large proportion of milk, it is the most suitable and sustaining beverage for most persons. Its large consumption throughout the civilised world is sufficient to prove both the estimation in which it is held and its value as an article of commerce. In a recent year the consumption in the United Kingdom was estimated at sixteen thousand tons, the total European consumption at seventy-five thousand tons, and the entire weight grown over the whole world about six hundred millions of pounds.

With so great a demand for coffee, it is not surprising that it should be liable to extensive adulteration. But the principal adulteration is with chicory, which is at least harmless, and by many is thought an advantageous addition. Chicory is prepared from the root of the wild endive, a plant of the same tribe as the dandelion and lettuce. It contains a volatile oil, to which its aroma is due, and also a bitter principle, but nothing analogous to theine or caffeine. When roasted it affords a beverage of like flavour and colour as coffee, and in moderate proportion is considered by many, both here and on the Continent, as a desirable addition. But it has not the peculiar sustaining quality of coffee, and being much cheaper it constitutes a fraudulent adulteration, unless the admixture be openly acknowledged. The admixture may be easily detected by shaking a little of the suspected coffee in a wineglassful of cold water. If pure, the coffee will swim, and scarcely give any colour to the water; chicory sinks, and gives a deep red tint. Attention has lately been called to a patent preparation called "Malt Coffee." This consists of a combination of malt, or malt extract, with fine coffee. Malt contains an active principle called diastase, an important nutritive agent, which assists in the digestion of bread and farinaceous articles. The preparation in question is said to contain 75 per cent. of coffee and 25 per cent. of malt, and if found as palatable as coffee mixed with chicory would certainly be preferable in many respects.

Cocoa.

Cocoa, or *cacao*, as it should properly be called, is prepared from the seeds of the *Theobroma cacao*, a native of the West Indies, Mexico, and the central regions of America. This is quite a different plant from that which yields us the common cocoa-nut, though, from its constitution, we might have spoken of it under the same head of oily seeds. It is, however, chiefly as a beverage that we employ it. The Spaniards, on taking possession of Mexico, found a beverage made from this fruit in common use by the natives, under the name of "chocottate," who had employed it from time immemorial. Foom the time of its introduction into Europe by the Spaniards it has been increasingly consumed by all civilised people. The generic term "Theobroma," or food of the gods, was given to it by Linnæus, by whom it was highly esteemed. The fruit is, in size and shape, like that of a small melon or cucumber, which contains in its pulpy flesh from six to thirty seeds or beans, something like those of the water-melon, but thicker and plumper. These, when separated, are cleaned and dried in the sun. It is in this state that they are imported. The seed consists of a firm, dark coloured, central part or kernel, surrounded by a brittle husk. In their natural state they have a bitter, acrimonious taste. Trinidad supplies the best that comes to this country, and the consumption of all kinds is rapidly increasing. In preparing it for use it is roasted in the same way as coffee, till the aroma has been fully developed, and then allowed to cool. It is then of a lighter brown colour, and has lost some of its natural bitterness and astringency. It is prepared in three different ways for use:—(1) It is beaten or ground into a paste, and mixed with starch, sugar, and often with other materials, and sold as "flake," "rock," or "soluble cocoa." (2) The bean is deprived of its husk, and then crushed into fragments, which form the cocoa nibs of the shops, and are the purest form in which the article can be obtained. (3) The bean, deprived of its husk, is ground into a paste between hot rollers, and afterwards mixed with sugar and different flavouring ingredients, and is then known as chocolate.

In composition cocoa resembles tea and coffee in containing a volatile oil or aromatic constituent, "theobromine"—the analogue of "theine"—astringent, and glutenous principles; but it has this marked distinction, that it contains a large amount of fatty matter, known as cocoa butter. The proportions of starch and gluten are also greater. From this it is manifest that it is a highly rich and nutritive variety of vegetable food, having a close resemblance to milk, the typical animal food. The following table from Johnstone will show the resemblance and the difference :—

	Dried Milk.	Cocoa Bean, dried.
Casein or Gluten	35	21
Fat	24	51
Sugar or Starch, &c.	37	22
Mineral or Saline matter	4	4
Theobromine	...	2
	100	100

The presence of theobromine gives to cocoa an exhilarating quality which milk has not, whilst the presence of a large amount of fatty matter renders it too rich for many stomachs. This objection is, however, met by mixing it with flour or starch and sugar, as is done in the manufacture of chocolate, which generally agrees with the stomach better than the pure cocoa. In the form of chocolate cake or "bon bons" it comprises all the elements for upholding the strength. As a beverage it is almost always combined with milk, and thus constitutes an admirable breakfast drink, particularly when from any reason either tea or coffee are objectionable, and it has far higher nutritive power. The infusion of cocoa nibs contains only a part of the nutritive matter of the bean, and is, therefore, less sustaining, but lighter of digestion. By boiling more is extracted, and this is, therefore, much more economical.

Another vegetable product having a similar name, "Coca," is the product of the *Erythroxylon coca,* and is used in South America by the natives much in the same way as tobacco is, or as opium is by the Chinese.

The widely extended—we might almost say the universal—use of these beverages which we have been considering naturally leads us to infer that they supply a common sense of need. What is this? It is not as simple food that they have come into such universal use, for tea and coffee, which possess the least of real nutriment, are more largely consumed than cocoa, which contains the most. The rich, who can command all and every kind of food irrespective of cost, and the poor woman who has not the means of obtaining a loaf of bread, alike demand and consume their quota of tea or coffee. The cultured man, exhausted by intellectual excitement and effort, and the miner or artisan, fatigued and worn by a long day's bodily labour, are equally comforted and restored by their cup of tea or coffee. Chemists and physiologists tell us that neither the one nor the other supply in any appreciable degree materials necessary for restoring the waste that has taken place during either intellectual or bodily exertion, and so maintaining the framework of the system. But carefully-conducted experiments and observation go to prove that there is an arrest of waste effected by each and all of these articles which contain "theine." They diminish the elimination from the system of those matters which indicate the amount of waste or disintegration that takes place during work of any kind, whilst the respiratory action is increased. They add little or nothing to the tissues of our body, but they retard or diminish any further wasting. They promote the assimilation and transformation of other foods and those various vital changes which are associated with the elimination of carbonic acid. This may possibly depend on their action upon the nervous system. That the brain and nervous system are specially influenced by these agents we have abundant proof. Their action is twofold, and to many people will appear paradoxical; it is both soothing and exciting. They will soothe and allay that general irritability and sense of hunger and exhaustion following labour, and they counteract the narcotic influence of opium and alcohol. Strong coffee is one of the most efficient antidotes to the poison of opium, and the heaviness and stupor of intoxication are relieved by both tea and coffee. The wakefulness induced by tea is the result of this counteracting influence, and the headache and trembling and excitement produced by strong coffee are indications of its stimulating action on the brain and vascular system. The poor needlewoman's sense of hunger and exhaustion is allayed by her tea, and she is able better to endure her cold and want of food; and the student's brain is saved from exhaustion by the cup of tea or coffee by his side. The torpidity and exhaustion occasioned by extreme cold are counteracted by the action of tea, which, by sustaining nervous power and promoting respiration, enables the system to maintain the animal heat necessary to life. Captain Burnaby, in his "Ride to Khiva," speaking of tea, says, "This beverage becomes an absolute necessity when riding across the Steppes in mid-winter, and is far superior in heat-giving properties to any wine or spirits. In fact, a traveller would succumb to the cold on the latter when the former will save his life." It is questionable whether in such circumstances the most nutritious beverages, such as soup or milk, will equally sustain nervous power and retard waste; although the time inevitably comes when true food must be eaten to maintain the nutrition of the frame. Of our material agents tea and coffee contribute probably more to the comfort and happiness of mankind than aught else. "The cup that cheers but not inebriates" conduces not a little to the contentment of the poor and the comfort of the rich.

CONDIMENTS.

Condiments, though not admitting of being considered alimentary substances, play an important part in dietaries. They may be said to be comprised under the several heads of salt, vinegar, peppers, and other pungent articles and aromatics. We shall have occasion to refer to them under a subsequent section as the means of rendering our food more palatable, and stimulating the appetite.

THE PREPARATION OF FOOD.

Having considered what are the alimentary principles required in the building up and sustenance of our bodily frame, and given a general account of the principal alimentary substances, or foods, which comprise these various principles in different combinations and proportions, we have now to consider in what way these different articles of food can best be made available, so as to secure the full amount of good they are capable of affording: how they can be most conveniently and efficiently employed.

Among other definitions that have been given of man, he has been called "a cooking animal." He is the only animal that prepares his food by cooking before he eats it. This implies that his organisation is such that he finds it necessary or advantageous to prepare his food so as to bring it into the most favourable condition to be acted on by his digestive and assimilating organs.

By assimilation is meant the various processes by which our food is converted into the different tissues and organs of our body—that is to say, converted to the same or a similar nature. The first of these processes takes place in the mouth and stomach. Our solid food is first masticated and mixed with saliva in the mouth before it is committed to the action of the stomach. A due consideration of the apparatus afforded by our jaws and teeth would at once show that we cannot masticate all and every sort of hard food. We cannot, without danger to our teeth, break up a peach stone so as to expose the kernel to be acted on by the stomach.

Many kinds of food, therefore, require some sort of preparation, in order to accomplish satisfactorily this preliminary operation. The next step towards assimilation is performed by the stomach, the action of which on the food is partly mechanical and partly chemical. As a mere machine, the stomach is adapted only to exercise a certain amount and description of force. This may be described as a churning action; the food is moved continually round the stomach, and from one end to the other, so as to be thoroughly mixed and brought into contact with the lining, or mucous membrane, whence the gastric juice is poured out. As regards its chemical action, this is analogous to chemical action exerted outside the body. Chemistry teaches us that there are certain conditions of matter that are favourable to the action of chemical force, and others that are unfavourable and obstructive. From the ordinary laws of chemistry we have learnt much regarding the chemical actions exerted by the stomach on our various articles of food. We can carry into effect out of the body most of the changes which we know are brought about by the chemistry of the stomach. We can show how many of these actions are facilitated or hindered. We can demonstrate, for example, that the white of egg is more readily acted on by the artificial digestive substance obtained from the stomach of a calf when uncoagulated than when coagulated and rendered solid; more readily when in the solid form it is broken up into fragments than when presented as a single mass. Much more of a like kind chemistry has taught us, and still more we have learnt by observation and experience regarding the chemical or digestive action exerted by the stomach on the constituents of food. Starchy food is converted in the stomach into gum and sugar; fatty and oily substances are minutely divided, and made into a sort of emulsion; caseine and other nitrogenous matters are liquified, and afterwards precipitated on passing out of the stomach; and all these changes are necessary for the formation of chyle, which is the first step towards the formation of blood, the ultimate destination of food. How it is that the stomach originates the secretions by which this chemical action is effected we know not. It is a vital act, and concealed in all the mystery that enshrouds life. So long as the vital powers are unimpaired, and the stomach is in a healthy state this chemistry goes on. When deranged by disorder and disease, the food is no longer acted on as it should be, and we have the evidence of this in the long and varied catalogue of dyspeptic symptoms and impaired nutrition.

Under this section, treating of the preparation of food, we have then to consider—

1. What are the circumstances affecting the digestibility of food?

2. How may it be prepared so as most effectually to economise its consumption and avoid waste?

3. How best may it be rendered acceptable to the palate, and also to the eye; for, as regards the appetite, this last is by no means unimportant?

If, however, we keep these several objects in view, it will perhaps save space and avoid repetition to discuss them conjointly rather than separately.

Cooking is both an art and a science, and good cooking implies both knowledge and skill. A cook need not be either a chemist or physiologist, any more than a philosopher; but he must have a certain amount of skill, acquired for himself by practice and experimental knowledge. Of the philosophy of his art he may have very little knowledge or comprehension, but his skill will be unavailing if it be exercised regardless of the teachings of science.

There are few things of more importance, as affecting the physical welfare and social comfort of the poorer and middle classes of the community, than a due knowledge of the elements of cookery. There is more food wasted than would suffice to support thousands of starving people. A wholesome, palatable meal would keep many a man from the public-house, and many a sickly child would be made strong and healthy by substituting wholesome, nutritious food, coarse and common though it might be, for the unwholesome and indigestible things on which they are forced to live. The attention that is now given to this subject in board and other schools is deserving of all support; but it will be long ere the British labourer, in this respect, finds himself on a level with the French peasant. The cooking of our middle-class establishments has much improved of late years, but both the maid-of-all-work and her mistress have yet much to learn. It is all very well for a hearty, vigorous man, fully occupied by his business, to say that he cares little what his food is, so long as it is ready when he wants it; or for the ascetic to sneer at the epicure, or for a strong-minded woman to despise all attention to so trumpery a matter as her husband's or even her own appetite and digestion. Neither bad air nor bad food are compatible with either sound mind or body. The laws of health cannot be contravened with impunity. The irritability and ill temper of a hungry, weary man are allayed by a wholesome, sufficient, and palatable meal, however right and important it may be to insist on the superiority of mind over body. Children may not only be kept healthy and happy, but more ready and capable to receive instruction, by being properly fed on wholesome and acceptable food. A new dress, a trip into the country, or a little laid by for a rainy day, may be secured by economic cookery without any stinting of what is needed for health and comfort. If some one says, who does not know and admit all this?—we reply, then why neglect the necessary means for securing these important ends? Why is there so much waste of food? How is it that there is so little attention paid to its preparation in the forms best adapted to secure the object for which it is taken? Habit and prejudice, as well as ignorance, have no doubt much to do with this. And it is not easy either to get rid of a bad habit or to improve national customs and tastes. But here, as in so many other cases, "knowledge is power;" and the object of this article, as well as of the others, is to diffuse information on subjects involving in so many ways the welfare of the community. Let us then, without further preface, proceed to inquire what are the circumstances connected with our different foods that affect their digestibility.

There is nothing of more importance than that the food should enter the stomach in a condition favourable to those chemical processes which consist in bringing about molecular changes. To this end, if not of a fluid form, it must be either already broken up or mashed, or be capable of being readily disintegrated. We seek, therefore, to lessen, as far as possible, the force of cohesion by which solid matters are held together. Skilful cooking does this, but unskilful may render the food still more dense and difficult of disintegration. As regards flesh food, tenderness of fibre materially aids its digestibility. This tenderness of fibre is influenced by the age of the animal and by the leanness or fatness of the meat, and by other things mentioned when speaking of meat. The flesh of animals killed after violent muscular exertion, as after hunting, is more digestible because more tender. Meat that has been much bruised is more tender because the fibres are thus broken up. Upon this principle a beef steak is beaten and bruised by a rolling pin before being cooked. The changes attendant on the incipient stage of decomposition render muscle more tender. Hence meat recently killed is less tender than that which has been hung for some days. Solid food, when in a state to be easily broken up, has been thought to be more easy of digestion than liquid food. This perhaps may be because it is more easily retained in close contact with the inner coat of the stomach. Everything that renders the food tender facilitates its mastication, and so brings it into a more favourable state for the action of the stomach.

The effect of cooking—*i.e.*, of heat upon meat—is to coagulate the fibrine and albumen, whilst it softens the gelatinous constituents, the connective tissue, by which the fibres are held together, and thus allows of their ready separation. Thus, what before was tough and tenacious becomes friable. Minuteness of division is equally important in the case of vegetable food, but generally much more easily effected. Potatoes, when cooked so as to fall asunder or be easily mashed, are more digestible than when half cooked, or when young or waxy and deficient in starch. But however tender solid food may be, and however readily broken up, a certain amount of mastication is desirable, because in this way it is subjected to the action of the saliva and the secretions of the mouth, which have a part in effecting those chemical changes through which all food has to pass. And inasmuch as these chemical changes are promoted by a certain elevation of temperature, the warmth given to food by cooking aids the action of the gastric juice. Other things being equal, warm food is more easily digested than cold.

Different modes of cooking have their respective advantages and disadvantages. By some the ultimate composition of the food is affected, though not by others.

Some are more economical than others; by some the food is rendered more palatable than by others. Some are specially adapted to particular kinds of food.

Boiling.—Meat when properly boiled retains more of its nutritious properties, and is rendered more easy of digestion, than when cooked in any other way; but it is generally considered less palatable. By boiling, both beef and mutton lose in weight less than by either roasting or baking. This loss amounts on an average to about a fourth of its weight. There is also a corresponding loss of bulk from loss of the juices and also from coagulation of the albumen, and if this be carried too far it becomes less rather than more tender; thus one of the main objects of cooking may be frustrated. The loss of weight being occasioned by the escape from the meat of its fluid and soluble parts, and as these admit of being collected and utilised, the loss is not really so much as it appears to be. But the degree to which the extraction of juices takes place depends on the degree of heat and its mode of application. The cook, therefore, proceeds in a different way, or should do so, according as he wishes merely to have a properly boiled joint, or to make from it broth or soup. If he wishes to make broth, the meat should be chopped fine and placed in cold water and allowed to soak for some time. Heat should then be applied gradually, and kept well below the boiling-point, so as to lose as little as possible of the albumen by coagulation. If, however, his object be to obtain stock for his soup, boiling must be kept up for some time to extract as far as possible all the gelatine which constitutes the basis of soup. The hardened albuminous matter which floats in the liquid is easily removed by straining, so as to render the soup clear. There will then remain in the vessel merely a dry fibrous mass of no taste and comparatively little nutritive value, which, however, the French peasant considers an important part of his "pot-au-feu." You cannot obtain both good meat and good soup from the same portion of meat, but the contents of the "pot-au-feu" are probably more satisfying and not less digestible when the exhausted meat is eaten together with the soup. If it is intended that the joint should be eaten as boiled meat, the object should be to retain as far as possible all the nutritive and flavouring properties. To this end the joint should be plunged at once into boiling water, with a view to induce speedy coagulation of the albumen of the outer portion, and thus form an impervious envelope that will prevent the escape of the juices from the interior. After continuing the boiling for five or six minutes, the heat should be reduced, so as to bring the water down to a temperature of about 160° Fahr. At this heat the cooking should be continued till the central portions are sufficiently coagulated as not to have a raw appearance, nor too much consolidated to render the whole mass hard. In the former case all the juices are retained, and the meat is both most nutritious and easy of digestion; in the latter case the main object of cooking is defeated, as the meat is shrunk and made dense and difficult of disintegration. There is no more common fault in boiling meat than keeping the water at too high a temperature after the first few minutes. Over-boiling is injurious to eggs by carrying the coagulation of the albumen (the white) so far as to render it solid; and as this coagulation goes on after the egg is taken out of the water, by the action of the contained heat, it is usual to crack the top of the shell and allow the heat to escape if the egg is not to be eaten immediately. Fish is made firmer and loses less of its flavour by being boiled in hard water, in sea-water, or in water to which salt has been added. Potatoes are best cooked by steaming rather than by boiling, and in their skins rather than peeled, as the object is to retain, as far as possible, those constituents which, being soluble, would be lost in the water in which they are boiled. In either case the heat should be continued till the starch cells have all been disrupted, so as to allow their contents to escape, and thus render the potato mealy. If they are to form part of stews or soups, there is no objection to their being peeled before they are cooked, because the extracted materials will form part of the food that is to be eaten. In the case of vegetables generally, the effect of boiling is to dissolve the gummy and saccharine material, and expel the volatile oils that many of them contain, as in the case of onions. Foliaceous vegetables—such as cabbage, greens, spinach, &c.—require to be thoroughly boiled to make them digestible. There is an additional important reason for preferring boiling as the method of cooking, and that is that any parasites or disease germs are thus more surely destroyed. In roasting, the temperature of the central parts of a joint may not have been sufficiently raised to effect this object, whilst in boiling it pretty certainly is. For the like reason, it is best to boil milk before it is drunk if there be any question of its being contaminated by disease germs.

Roasting, next to boiling, is the best form of cooking. The same principles apply as in boiling—*i.e.*, the heat should be sharp at first, till a layer of consolidated tissue has been formed on the outside, and then the temperature reduced, so as gradually to coagulate the albumen of the interior without shrivelling up and hardening the fibre. But in roasting, a portion of the osmazome and fat are necessarily lost by exuding from the meat into the dripping-pan. Osmazome is the extractive matter on which the odour and flavour of the meat depend. Some of this passes out into the gravy, and some forms a coating on the outside of the meat. The fat is not only in a measure lost, but if the heat be so great as to scorch the meat, it undergoes chemical changes, and becomes disagreeable and injurious. As in roasting the heat is not applied so uniformly and gradually as in boiling, the outer portion is more apt to be over-done before the central portions are sufficiently cooked.

The flesh of young animals is better adapted for roasting than for boiling, because it abounds in those principles which readily dissolve in water, and which may be boiled away. Whenever it is specially desired to retain and increase the flavour, roasting is the preferable method, as in the case of pork, venison, and game, and generally poultry, unless they be lean and old, in which case their digestibility is improved by boiling.

Broiling has much the same effect as roasting, and is the best mode of cooking fresh-water fish, and generally all small fish, such as whitebait and smelts.

In *baking*, the temperature is more equally maintained, and the sapid constituents are not so much dissipated. Hence the joint is richer in flavour, and the juices more fully retained. But for these reasons it is less adapted for delicate stomachs, and unless great care be taken not to allow the fat to come in contact with the hot iron of an ordinary oven, it is apt to acquire disagreeable and noxious qualities from the burnt fat. The metal ovens in common use in private establishments cannot be kept too scrupulously clean. There is hardly anything more offensive to a delicate stomach or palate than the flavour which food acquires from the action of heated iron on the greasy materials with which it is apt to be coated. Every oven should be provided with means for ventilation.

Stewing holds an intermediate place between boiling and roasting, and it is by far the most delicate and secure mode of rendering the meat tender, juicy, and sapid. Meat that would otherwise be eaten and digested with difficulty may thus best be utilised. It admits of combining a number of different articles, both animal and vegetable, and rendering those tasteful that would otherwise be flavourless. There is a good deal of ill-founded British prejudice against this method of cooking. No doubt stews will offend a delicate stomach if they be over-flavoured by spices and pot-herbs, and still more frequently if bad butter be used, or the cooking unskilful. But all the nutritious properties of the least nutritious materials may thus be obtained, and each item of the stew rendered tender and soluble. It is often the best way of employing tinned preserved meats. The process should be conducted slowly, and always below the temperature of boiling, otherwise the meat may be rendered hard. *Hashing*, which is the same process, used for meat that has previously been cooked, too often fails from this simple reason, and the meat, which was tender and sufficiently disintegrated, is made tough and leathery. Very little water is needed for stewing; indeed, it may be done without, the juice of the meat and other articles proving sufficient, if care be taken to avoid burning. This is best effected by placing the materials in an earthern jar, with a loose cover, and immersing it in a saucepan or kettle of water that is kept gently simmering. The most dainty dishes may in this way be made, provided the cook have the requisite skill and judgment in the selection of the ingredients.

Soup is often looked on merely as a light kind of food—as a preliminary or adjunct of other foods; but it is the staple article of diet in some countries. It affords also the best mode of economising food. It admits of using all the waste fragments of food and various articles, the nutritive value of which could scarcely, in any other way, be made available. The French peasant, whose "pot-au-feu" is always ready at hand by the fire to receive almost any and every thing from which nutriment can be extracted, makes it, with the addition of bread, his main sustenance. It admits of being still further enriched by rice, oatmeal, or almost any farinaceous addition. But our poorer classes have yet to learn the merits, both economic and nutritive, of soup thus made, and our middle-class housewives have to learn that it is not necessary to buy a shin of beef in order to keep the kitchen supplied with the all-useful "stock." In using bones for the purposes of soup, they should be first broken up into fragments, and submitted to prolonged boiling, in order to extract all the gelatine; but they will not alone make good soup. The bony remains of some fish, especially turbot, which are rich in gelatinous matter, may be advantageously used, as well as meat bones. The history of ox-tail soup, now considered one of our most esteemed rich soups, is interesting, as showing how good things are often neglected, till accident or necessity brings them into notice. "It was at one time the humble fare of the poor Protestant refugees, who fled from France at the revocation of the edict of Nantes in 1685, and settled in Spitalfields and Clerkenwell. In the extremity of want, they purchased from the tanners of Bermondsey the ox-tails which were then sold with the hides, and made them into soup. Accident brought it under the notice of a philanthropic epicure, who was on a mission of charity to the homes of the poor foreigners, and he proclaimed its virtues, so that erewhile it became a fashionable dish" (Letheby). Kangaroos' tails make a still richer soup, and are now imported for this purpose. Extracts of meat are now extensively made in South America for exportation to Europe. One pound of this represents the soluble constituents of from 45 lbs. to 48 lbs. of ordinary butcher's meat, and it has been assumed that the nutritive power is in the same ratio. This, however, is shown by Liebig, to whom we are indebted for its introduction, to be an error, as the extract only represents the *beef-tea* obtainable from that quantity of meat, and is devoid of the albumen, which requires to be represented by some other article, such as beans or peas. Without some such addition the action of the extract is considered to be analogous to the active principles of tea and coffee (theine and caffeine), which we have spoken of as vital restoratives rather than nutriments. Indeed, the stimulating action of a large dose of "Liebig" will sometimes have a decidedly intoxicating effect, as though so much fermented liquor had been taken. The preparation, however, is valuable, being portable, capable of being kept, and administered in various ways, either alone or with wine, as a restorative, or, associated with leguminous seeds and farinaceous material or with eggs, as a sustaining food.

"A still more nutritious broth," says Letheby, "containing the albumen of the meat, as well as the soluble extract, is obtained by infusing a third of a pound of minced meat in 14 ozs. of cold soft water, to which four or five drops of muriatic acid and a little salt (from 10 to 18 grs.) have been added. After digesting for an hour or so, it should be strained through a sieve, and the residue washed with 5 ozs. of water, and pressed. The mixed liquids thus obtained will furnish about a pint of cold extract of meat, containing the whole of the soluble constituents of the meat (albumen, creatine, &c.), and it may be drunk cold, or slightly warmed, the temperature not being raised above 100° Fahr., for fear of coagulating the albumen." If such broth or a little "Liebig" be added to fresh vegetable "stock," made with a judicious selection of vegetables and pot-herbs, an excellent light soup may be made with very little trouble.

In the cooking of vegetables, it should be remembered that all woody tissues, whether in the roots or stalks, or in the husks and skins, are well-nigh devoid of nutriment, and quite indigestible, and should therefore be removed. Vegetables should generally be boiled, and sufficiently long to disintegrate the tissues and allow of the starch granules being duly broken up. As the saline and saccharine constituents are extracted by the water, vegetables necessarily lose somewhat of their main elements, especially if the water be soft. This is obviated by adding a little salt to the water. By this means also the colour of green vegetables is preserved. Nothing, however, must be allowed to endanger the principal object, which is to render the vegetable tender and readily disintegrated.

It would be impossible in an article of this kind to go into the details of cookery.

This must, to a great extent, be learnt by practice; but there are many excellent manuals for the instruction of the ignorant.*

Such books are necessary for teaching the varieties and methods of preparing what are termed "made dishes," or "entrées." It is a great mistake to suppose that all such food is unwholesome and to be avoided. On the contrary, it is often not only appetising and useful, from giving variety to the diet, but more easy of digestion than simpler but more solid food. Skill and care, however, are much needed in the preparation of such dishes; otherwise they should by all means be avoided. Nothing is worse than bad French cookery; and as in such dishes, butter and sauces of various kinds, condiments and adjuncts innumerable, are often profusely and indiscriminately employed, it is manifest that they must often be most objectionable for persons of weak digestion. The fatty and oleaginous materials with which they abound are often the chief cause of their disagreeing, especially as these not infrequently are either not of the best quality, or have been so acted on by heat as to be made specially noxious.

As a part of such dishes, macaroni and rice may often be employed with advantage, so as to exclude other vegetables that it may be desirable to avoid. These special dishes, or "entrées," are generally partaken of in small quantities, and it may often be better to take sparingly of two or three dishes than run the risk of overtaxing the stomach by eating more heartily of a single solid joint. Each one should exercise his own discretion, and learn from his own experience, what particular articles or particular modes of cooking do not suit him. There is doubtless danger when there is much choice of a variety of tasty and tempting food, and, as a rule, a simple diet is the safest, and "hunger is the best sauce." We are, however, reminded that such remarks as these fall more properly under the head of dietaries, rather than of modes of preparing food.

The principles to be kept in view in preparing *Tea* and *Coffee* as beverages may be gathered from what has been said under those heads when treating of them as articles of food, and but little more need be said here. And yet, notwithstanding the constant daily use of these valuable beverages, much difference of opinion prevails as to the best mode of preparing them. In the preparation of tea, the aim should be to extract all the aroma and the dried juices containing the theine, with only so much of the substance of the leaf as to give a certain body to the infusion. That the beverage should be an infusion, and not a decoction, is pretty generally allowed; but there are two ways of making the infusion. The more usual method is to pour boiling water on the tea, and keep up the temperature as near the boiling-point as may be for a certain length of time. For most kinds of tea five to ten minutes is sufficiently long to obtain the theine and the aromatic principles, and this is all that many persons wish or find desirable. If the infusion be much longer prolonged at a high temperature, the theine may be more completely exhausted, but there will also be obtained much of the tannin, which gives astringency and bitterness, and often occasions indigestion. The finer the tea, and the younger the leaf, the longer will it admit of being infused, so as to exhaust the theine without correspondingly increasing the tannin. But if coarser tea of older leaf be used, prolonged infusion will only diminish the flavour, whilst the tannin will be increased. "Cosies," which are now so generally used, afford the best means of keeping the infusion at a proper temperature. There is, however, another mode of making the infusion which has its advantages. The tea may be put into a vessel (small urn) filled with cold water, and then gradually heated by means of a lamp till it just boils, allowing fully ten minutes for this. The Chinese infuse the tea, at once, in hot water. The Japanese grind the leaf to powder, and, after infusing it in the teacup, beat up the mixture into a frothy state with a slip of bamboo, and then drink powder and all. The Chinese, who are good authorities, never use either very soft or very hard water for the infusion, and the result of a careful inquiry on this subject by a Government Chemical Commission showed that a moderate degree of hardness of the water was advantageous. It is a very common notion that soft water makes the best tea, and therefore a pinch of soda is often put into the pot; but unless the water be very hard, from the presence of lime, this is not desirable, as the soda extracts more of the astringent and bitter principle, and so makes the tea look stronger, but the flavour is thereby injured. Tea tasters are understood to use only freshly-boiled water, and the Chinese prefer water taken from springs on the hills, which is always aerated, and contains more or less of saline matter.

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* One of the most useful, from giving clear and specific directions as to proportions, modes of preparing, and time needed for particular dishes, is "Cassell's Dictionary of Cookery."

We generally measure the tea put into the pot by teaspoonfuls, without regard to the kind of tea that we are using and the different weight of a spoonful of different teas.

The following table gives the average weights of a spoonful of different teas, as ascertained by Dr. E. Smith :—

WEIGHT OF A SPOONFUL OF TEA.

Black Teas.	Grs.	*Green Teas.*	Grs.
Oolong	39	Hyson	66
Congou (inferior)	52	Twankay	70
Flow'ry Pekoe	62	Fine Imperial	90
Souchong	70	Scented Caper	103
Congou (fine)	87	Fine Gunpowder	123

By calculation from this table, it appears that to obtain, by means of a quart of boiling water, tea of a certain average strength, from three to seven teaspoonfuls of black tea are required, and from two to four of green tea.

In preparing *Coffee* for the table we must remember the importance of having it freshly roasted and ground, but it is still a debated question whether it should then be boiled or not. It seems, however, to be admitted that when mixed with chicory, as it generally is on the Continent, the flavour is improved by a brief boiling, and by allowing a longer time for maceration than is generally given by us. But, whatever may be the causes, coffee as usually prepared at our railway stations and taverns especially, and in many private houses, is a disgrace to a nation that possesses the most abundant supply of the best material. Good coffee may be made by the poor as well as by the rich by pouring boiling water on the coffee in a common jug with a cover, and allowing it to stand by the fire for ten or fifteen minutes. It then only needs to be poured off carefully to be had clear, or it may be passed through a piece of muslin into the cup. There are, however, advantages in using one or other of the various coffee kettles or percolators now to be obtained.

The vile abomination passing under the name of coffee is too often made from compounds containing but little real coffee, and that of the poorest quality. Besides a large proportion of chicory, burnt beans and other similar things take the place of coffee. In private establishments, the failure to make good coffee is frequently owing to the use of too small a quantity of the article, as though it were tea, whereas four ounces of coffee are about equal to five teaspoonfuls of tea, as regards the proportion of the material to be extracted by a quart of water. It seems very undesirable that coffee as publicly sold should be allowed to have a certain proportion of chicory mixed with it. This opens the door to other more objectionable adulteration. It would be much better to insist on the two substances being sold separately.*

PRESERVATION OF FOOD.

All articles of food tend more or less speedily to become disorganised and pass into decomposition—some more rapidly, others not till after they have been long kept—provided they are exposed to a certain degree of warmth and moisture, and to the air. If the food be effectually protected against all these influences, it may be kept for an indefinite time. It is needless to show how important the preservation of food may be to whole communities, and how great may be the saving of food that would otherwise perish.

Drying and salting were the methods anciently resorted to, and which are still employed for various articles. Drying is better adapted for vegetable than for animal substances. Of this we have the most familiar illustration in the making of hay and in hops, tea leaves, pot herbs, &c., the preservation of which is still more effectually secured by pressure, thus excluding air, and bringing the material into the condition of a more or less solid mass.

There are now various processes, many of them patented, for preserving both animal and vegetable food, both on the principle of excluding them from the air, and maintaining them at an extremely low temperature. Pemmican, so largely employed by our Arctic voyagers, consists of dried powdered meat mixed with spices, and eaten with fat or meal of some kind. Milk may be desiccated, and be preserved so as to retain in a wholesome state all its nutritive property.

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* An anonymous writer in the *Times* gives the following directions for the preparation of what an Oriental understands by coffee :—"Obtain pure Mocha only. Roast the quantity required over charcoal fire in revolving cylinder turned slowly. Eschew those abominations known as grinders, and crush small with pestle and mortar. Take one teaspoonful to each two large egg-cups of coffee required. Place into boiling water in plain vessel which will stand fire. A chocolate froth will gradually appear ; nurse it gently by taking off, and replacing on fire until one bubble appears. Then withdraw and pour out, taking care, if you have more than one cup, to fill each cup half full first, and to divide last half among all cups. This, and this only, will give you COFFEE."

At present there are several sources for the supply of condensed milk. By some methods cane sugar is added, and the milk then concentrated, in vacuo, to the consistence of honey. A pure condensed milk (known as Swiss milk) is now supplied, prepared without the addition either of sugar or any antiseptic, by a process by which, at the same time that the concentration is effected, any disease germs that might be present are effectually destroyed. This variety of condensed milk, when suitably diluted, is specially fitted for the artificial feeding of infants. It is far better than many of the Infants' Foods which are advertised, which are all of a more or less composite character, whereas the condensed milk may either be given alone, properly diluted, or may be associated with other nutriments as circumstances may require, or under the direction of medical authority.

In illustration of the efficiency of some of the processes for preserving food, Dr. Letheby showed to the Society of Arts in 1868 a specimen of mutton in excellent condition, which had formed part of the stores sent out by the *Fury*, which was wrecked in Regent's Inlet in 1825, when various stores were left upon the beach. Eight years afterwards they were found in good condition by Sir Jno. Ross. Some of the cases, after a further interval, were found by H.M.S. *Investigator*, the provisions being still in excellent preservation, although they had lain exposed to the weather and a range of temperature from 92° below to 83° above zero for nearly a quarter of a century.

Food may be preserved by being coated with some material impervious to air, such as fat, oil, paraffin, or collodion. Eggs, we have seen, may be kept by covering them with a coating of oil; or, as is more commonly done, by immersing them in milk of lime, made from recently slaked lime. For illustration of the efficacy of the preservative power of lime, it has been recorded that, some years ago, when a sacristy in the neighbourhood of the Lago Maggiore was pulled down, eggs quite fresh were found embedded in the mortar, which had existed for perhaps three hundred years. Sausages and similar articles, and lard, are preserved, for a time, by packing them close in skins and bladders, to protect them from the air. The same principle is adopted in making potted meats by covering them with melted butter, and in the case of sardines and anchovies by immersing them in oil.

But the principle is still more strikingly illustrated by the bottled and tinned foods which are now so extensively used. The food having been introduced into the bottle or tin, the vessel is heated so as to cook the contents and drive out the air by the generation of steam, and then rapidly and hermetically sealed. Fruits, vegetables, meats, and fish, may thus be preserved for an almost indefinite time, and retain all the virtues and most of the characteristics of the substance in their fresh state. There are various establishments in Australia and South America where this process is carried out on a very extensive scale, and many tons of food are annually exported which till recently were absolutely wasted, the animals having been killed for their hides, horns, and fat, whilst the meat was used for manures. Large quantities of fruits, both moist and dry, are imported, protected by sugar, in closed vessels.

It is well known that meat will keep longer in cold than in hot weather—in winter than in summer. The fact is now well established that in the Arctic regions the bodies of animals will remain imbedded in ice for ages without undergoing decomposition. The Mammoth, an extinct animal, has been found in the frozen soil of Siberia in an entire state. In Russia and other northern states it is the practice to slaughter animals on the approach of winter, when fodder becomes scarce, and to preserve their carcases till the following spring by burying them in the frozen earth. In the autumn of 1861, the mangled bodies of three Chamounix guides were found in the lower end of the Glacier de Boissons, who had perished by being carried away by an avalanche while attempting to scale Mont Blanc with Dr. Hamell in the year 1820. The flesh of the bodies of these unfortunate men was perfectly preserved after an interval of forty years. It is now a common practice to pack salmon and game in ice, and transport them from one continent to another; and the ice for this purpose may be either imported from Norway or the Wenham Lake, or it may be manufactured to any amount at a very small expense. Small ice safes may now be obtained for a very moderate sum, in which butter, milk, fish, and meat, may be kept by private families sufficiently long to avoid the loss that would otherwise occur in hot weather.

Various chemical agents, termed antiseptics, are now employed both for the purpose of destroying fungi and infusorial germs, and for effecting chemical changes in the food which render it less prone to decay. Common salt acts in this way. If, however, the process of salting be injudiciously performed, the juices of the meat and its saline constituents are lost in the brine, and the wholesomeness of the food is seriously impaired. Moreover, the meat may be rendered so dense as to be very indigestible. Hams, tongues, herrings, and other fish are preserved in this way. Saltpetre and some other salts are employed for this purpose, as are also vinegar and alcohol, of which our various pickles and brandied cherries may be taken as examples.

Meat and fish after being salted are often dried and smoked. By submitting the meat or fish to peat or wood smoke in close chambers, it becomes impregnated with the empyreumatic oil of the burning wood, and thus acquires its peculiar flavour and smell. As it is the creasote of the empyreumatic oil which is the chief agent in the preservative process, this is now much used instead of smoking. A certain quantity being mixed with vinegar is rubbed over the salted joint, which is then dried. More recently borax has been brought into notice as a disinfectant and means of preserving food. The history of its discovery as a preserving agent is interesting. Mr. A. Robottom, when visiting California in 1874, discovered numerous deposits of borax and boracic salts. Wearied by arduous travel across a desert of loose sand and beds of salt, he sat down on the first convenient object, which turned out to be the carcase of a horse, which, though it had been dead seven months, was preserved from putrefaction by the borax and borate of lime, with which it was surrounded. This led to the formation of a company for the supply of a patented preparation, containing borax, for disinfecting and preserving purposes.

It is needless to say that the admixture of food with any of these disinfecting agents is open to various objections, notwithstanding their value.

EMPLOYMENT OF FOOD.

We now enter on a most important division of our subject, and have to consider how the various alimentary substances of which we have treated can be most advantageously employed to accomplish the ends for which they are required. These, we have seen, are twofold—the one being to supply the various organic and inorganic materials of which our bodies are composed, and the other to provide means for the maintenance of the heat of the body and the production of force necessary for the performance of its various vital actions. It will at once be evident that the amount and kind of food demanded will differ according as the one or the other of these leading objects is sought. Whilst the body is growing, we have to provide for the increase as well as maintenance of the organism. When actively employed great waste is going on, and this waste must be restored sooner or later. When exposed to severe cold, or when deprived of the requisite clothing and shelter, there is greater need for means by which to sustain the temperature at the point below which life is impossible. The amount and kind of food will, therefore, be found to vary according to age, work, climate, and season, as well as other circumstances. And as we have seen that our frame is built up of various constituents, in various proportions, our food must be made to supply these constituents in their due amount and proportion.

Taking carbon and nitrogen as the representatives of the non-nitrogenous and the nitrogenous alimentary principles, it appears, from a large number of observations made by Dr. Lyon Playfair, Dr. E. Smith, and others, that the minimum daily quantity of food on which an ordinary individual can exist and continue in health is as follows :—

	Carbon (grains).	Nitrogen (grains).
Adult Woman	3,900	180
Adult Man	4,300	200
Average Adult	4,100	190

These proportions, in what must be called a famine diet according to Letheby, are contained in 2 lb. 4 oz. of bread—that is, 36 oz. ; and agree with another set of facts derived from an examination of the amounts of carbon and nitrogen exhaled and secreted from the body during health and idleness. The mean average of several subsistence dietaries as given by Dr. Pavy is as follows, drawn from certain prison and other dietaries, and from the average diet during the cotton famine in Lancashire :—

Nitrogenous Matter	2·33 ozs.
Fat	0·84 „
Carbo-Hydrates	11·69 „

As a fair representation of what may be considered a standard diet, or a diet containing in due combination the principles needed for maintaining the health of an individual of average height and weight, performing a moderate amount of muscular work, in a temperate climate, Moleschott gives the following:—

ALIMENTARY SUBSTANCES IN A DRY STATE REQUIRED DAILY FOR THE SUPPORT OF AN ORDINARY WORKING MAN OF AVERAGE HEIGHT AND WEIGHT.

Dry Food.	In oz. Avoir.	In Grains.
Albuminous or Nitrogenous Matter . . .	4·587	2,006
Fatty Matter	2·964	1,296
Carbo-Hydrates, Starch, etc.	14·250	6,234
Salts	1·058	462
Total	22.859	9,998

In this diet it will be observed that a fifth part consists of nitrogenous matter, a much larger proportion than is represented above in the famine diet, and the 23 oz. of dry food given by Moleschott will represent 46 of solid food as ordinarily taken, assuming 50 per cent. as the average amount of water in such food, and there would probably be as much more taken in some form or other in connection with such a diet, making the total amount of water 70 oz. to 80 oz. Both these tables must be taken as approximating to the amounts and proportions of food required in the two examples, as it is evident that there will be considerable differences in individual cases.

As we shall subsequently have to speak of the relative amounts of different foods required in different conditions and circumstances of life, it will help our readers if we give here for reference two tables—the one by Dr. Letheby, showing the different proportions of nitrogen in different foods, and the other the comparative composition and nutritive value of our chief alimentary materials, as given by Parkes.

PROPORTIONS OF DIFFERENT FOODS REQUIRED TO YIELD 1,220 GRAINS OF NITROGENOUS MATERIAL, ASSUMED TO BE REQUIRED FOR A MAN'S DAILY DIET.

	Grains.	Pounds.
Skim Cheese	2,723	0·4
Lean Meat	6,421	0·9
White Fish	6,740	1·0
Fat Meat	8,971	1·3
Fat Bacon	12,449	1·8
Bread	15,062	2·1
Rice	19,365	2·8
New Milk	29,756	4·2
Potatoes	58,095	8·3
Parsnips or Turnips	111,000	15·9
Beer or Porter	1,110,000	158·6

NUTRITIVE VALUE OF DIFFERENT FOODS.

Articles.	In 100 Parts.				
	Water.	Albuminates.	Fats.	Carbohydrates.	Salts.
Meat of best quality, with little fat, like beefsteaks	74·4	20·5	3·5	—	1·6
Uncooked Meat of the kind supplied to soldiers—beef and mutton. Bone constitutes one-fifth of the soldier's allowance	75	15	8·4	—	1·6
Uncooked Meat of fattened cattle; calculated from Lawes' and Gilbert's experiments. These numbers are to be used if the meat is very fat	63	14	19	—	3·7
Cooked Meat, roast; no dripping being lost. Boiled assumed to be the same.	54	27·6	15·45	—	2·95
Salt Beef (Girardin)	49·1	29·6	0·2	—	21·1
Salt Pork (Girardin)	44·1	26·1	7·0	—	22·8
Fat Pork (Letheby)	39·0	9·8	48·9	—	2·3
Dried Bacon (Letheby)	15·0	8·8	73·3	—	2·9
White Fish (Letheby)	78·0	18·1	2·9	—	1·0
Poultry (Letheby)	74·0	21·0	3·8	—	1·2
Bread, white wheaten, of average quality	40	8	1·5	49·2	1·3
Wheat Flour, average quality	15	11	2·	70·3	1·7
Biscuit	8	15·6	1·3	73·4	1·7
Rice	10	5	·8	83·2	0·5
Oatmeal (Letheby)	15	12·6	5·6	63·0	3
Maize (Poggiale)	13·5	10	6·7	64·5	1·4
Peas (dry)	15	22	2	53	2·4
Potatoes	74	1·5	·1	23·4	1
Carrots (cellulose excluded)	85	·6	·25	8·4	·7
Cabbage	91	·2	·5	5·8	·7
Butter	6	·3	91	—	variable; taken as 2·7
Egg (10 per cent. must be deducted for shell from the weight of the egg)	73·5	13·5	11·6	—	1
Cheese	36·8	33·5	24·3	—	5·4
Milk (sp. gr. 1,030, and over)	86·7	4	3·7	5	·6
Milk (sp. gr. 1,026)	90	3	2·5	3·9	·5
Cream (Letheby)	66	2·7	26·7	2·8	1·8
Skimmed Milk (Letheby)	88	4·0	1·8	5·4	0·8
Sugar	3	—	—	96·5	·5
Pemmican (de Chaumont)	7·2	35·4	55·2	—	1·8

We have frequently alluded to the two-fold purpose served by food—the sustenance of the material frame, and the production of heat and force; but we must endeavour rather more fully to explain the subject of heat or force production.

The generation of the heat of the body is the result of the chemical action that is always going on, both when the elements of food are passing through the various combinations requisite for the formation of the tissues, and when, in the process of respiration, the oxygen of the air taken into the blood enters into combination with the carbon of the tissues, and so is burnt. Certain foods, from their constitution, are specially adapted to undergo combustion, whilst others are specially adapted to the formation of flesh and the other solid constituents of the body. Foods, therefore, are roughly divided into flesh formers, and heat or force producers. We say roughly divided, because flesh formers, in the various combinations through which they pass, generate heat, and the heat producers contribute to form certain tissues, especially fat. This distinction between flesh-forming and respiratory foods was first established by Liebig, and though, in certain respects, his doctrines have been modified by recent chemical investigations, the broad distinction between these two classes of food laid down by Liebig still holds good.

Now, the modern doctrine of the correlation of forces has shown that the generation of a certain amount of heat has a definite relation to a corresponding amount of mechanical force, and *vice versa.* Many familiar examples of the generation of heat by chemical action might be given, as during the germination of seeds, the heating of haystacks, the combustion of coal or gas; and every one is familiar with daily examples of the production of heat by motion, as by friction. An engineer can now accurately calculate the amount of energy to be obtained by the combustion of a certain weight of coal.* This subject in its relation to food has been ably worked out by Professor Frankland, who, by such tables as the following, has shown the amount of heat and equivalent amount of force generated by the complete combustion within the body of various alimentary substances of like weight.

Food.	In combustion raises	Which is equal to lifting
	lbs. of water 1 degree Fahr.	lbs. 1 foot high.
10 Grains of dry flesh	11·23	8·677
„ „ „ Albumen	10·94	8·453
„ „ „ Lump Sugar	8·61	6·647
„ „ „ Arrowroot	10·06	7·766
„ „ „ Butter	18·68	14·421
„ „ „ Beef Fat	23.32	18·023

"Thus," says Dr. E. Smith, "we prove that one ounce of fresh lean meat, if entirely burnt in the body, would produce heat sufficient to raise about 160 lbs. of water 1° Fahr., or a gallon of water about 16° Fahr. In like manner one ounce of fresh butter would produce five times that amount of heat; but it must be added that, as the combustion which is effected within the body is not always complete, the actual effect is less than that now indicated."

In this way, then, the heat of the body is maintained, and means provided for the production of force, in walking or other exercise, in the action of the heart, and the performance of other vital actions. But assuming that all the food mentioned in the above table was thus destroyed by being burnt, we should still need a supply of material for the machine, which is constantly undergoing waste, and would soon be incapable of working, unless its organisation was maintained. So ceaseless is this waste and change of substance that the atoms which compose a muscle one hour may be gone the next, and each structure requires to be replaced by the same kind of material as that of which it is composed : muscle by muscular fibre, nerve matter by nerve matter, bone by bone.

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* Force—whatever causes movement. Energy—power of doing work.

According, then, to the demand for the supply of each of these requirements, must be the supply and character of the food. In meeting these demands, it must be remembered that the food taken is not all digested and utilised ; some passes out of the body unchanged, and as regards that amount of energy which is liberated by the food that is completely oxidised, or burnt, Helmholtz has calculated that only about one-fifth can be turned to account in the form of external work.

From the consideration of these important results of careful scientific investigations, and from what has been said in former sections, it will at once be inferred that our daily food cannot consist of materials comprising only one alimentary principle, but must afford a combination of these. And this has been proved by direct experiments. Animals fed on articles consisting of only one alimentary principle cannot be kept alive long. The continued use of a diet greatly deficient in any one principle has again and again been productive of disease and calamity. For the continued maintenance of health, a diet must comprise not only nitrogenous, or albuminous food, salts, and water, but also non-nitrogenous, such as fat, sugar, and starch. The respective amounts of these that will be required will vary with climate and exposure to cold, and also with the degree of active muscular work performed.

The requisite average amount of food of all kinds and of water differs considerably in different men, according to their size and vigour, and the activity with which their bodily functions are performed.

The average, in male adults, as given by Parkes, is 34 oz. to 46 oz. of what is called solid food, and from 50 oz. to 80 oz. of water. When undergoing great exertion more food is taken, and instinct prompts to increase the amount of nitrogenous material and of fat. The amount of water that will be taken varies still more.

Average daily water free diet, required for an adult man, in very laborious work, or of a soldier on service and in the field.—(Parkes.)

	Ounces Avoir.
Albuminates or Nitrogenous Matter	6· to 7·
Fats	3·5 to 4·5
Carbo-hydrates	16· to 18·
Salts	1·2 to 1·5
Total water free food	26·7 to 31·

Average daily diet of men in quietude.—(Parkes).

	Rest.
Albuminates	2·5
Fats	1·
Carbo-hydrates	12·
Salts	0·5
Total water free food	16·

Subsistence diet—i.e., sufficient for the internal mechanical work of the body.—(Playfair).

Albuminates	2·
Fats	·5
Carbo-hydrates	12·
Salts	·5
Total water free food	15·

Assuming the average amount of water contained in these materials to be 50 per cent., the above weights must be doubled.

The following table gives the results of Dr. Playfair's investigations respecting the average amount of the several constituents of food in the daily dietary of an adult man under different circumstances of existence.

DAILY DIET ACCORDING TO WORK DONE.

Daily diets for	Flesh former.	Fat.	Starch and Sugar.		Nitrogenous.		Carbonaceous calculated as Starch.
	ozs.	ozs.	ozs.		ozs.		ozs.
Subsistence only . .	2·0	0·5	12·0	=	2·0	+	13·3
Quietude . . .	2·5	1·0	12·0	=	2·5	+	14·5
Moderate exercise .	4·2	1·8	18·7	=	4·2	+	23·2
Active labour . .	5·5	2·5	20·0	=	5·5	+	26·3
Hard work. . .	6·5	2·5	20·0	=	6·5	+	26·3

It is well known that in cold climates very large quantities of food are consumed, and it is generally allowed that we require and take more food in winter than in summer. This may, in a measure, depend on the different degrees of activity manifested, but it is doubtless largely due to the necessity of generating the requisite amount of heat.

The appetite for food is greater on a cold, frosty day, than in hot, relaxing weather, although in the latter case there may be a greater feeling of exhaustion; and the appetite must be allowed to be the main guide to the amount of food required. Hunger is nature's intimation that food is needed. The appetite may be pampered, but the sense of hunger is, in the healthy state, the true index to the requirement for food; and the satisfying of hunger is nature's intimation that enough has been taken. It is safer to act on the rule of leaving off with an appetite, than to go on to repletion till met by the stomach's refusal to be further burdened. In a state of health, a great variety of food at any one meal is seldom desirable, though in our artificial modes of life, in exhausted states of system, and in impaired health, it may often be desirable to stimulate the appetite by variety of easily-digestible and tasty food, rather than strive to satisfy the requirements of the system by taking a larger amount of more simple food than the appetite would dictate. But the danger is great when the epicure, for the mere gratification of the palate, not only indulges in a vast variety of dishes, but stimulates his pampered appetite by condiments and provocatives of all kinds. When food is good and abundant, and no necessity for economy exists, it may be safely said that very many, if not most, people take more food than is necessary for the wants of the system, and especially of the more solid kinds of animal food.

The amount of liquid required varies even more than in the case of solids, both in individual instances and in different circumstances of life. Thirst is nature's call for liquids, but there are some people who scarcely know what thirst is; there are others, again, who seem to be always ready to drink, either from actual thirst, or from sense of the need of liquid, or from habit. A free supply of water, or other simple fluid, may be said to be desirable; but the amount will vary with the kind of food. An average adult man probably requires from 80 oz. to 100 oz. a day of fluid, and if 20 oz. of this be taken in the solid food, from 60 oz. to 80 oz. in addition will be needed; but as the daily loss arising from elimination through the lungs, the skin, and the kidneys varies, especially by the two latter channels, so will the needed supply. Where the diet consists largely of fruits and vegetables, there will be less need for liquids in a separate form; and where, as is often the case, freer elimination by the skin and kidneys is desirable, a more abundant supply of liquid will be necessary. Active out-of-door exercise, especially in hot weather, entails great loss of fluid from the skin, and a corresponding demand for fresh supply. Pedestrians differ as to the desirability of supplying this loss during the time of exercise, but if not then, it requires to be made good when the exercise is over. Under the head of "Water," we have already mentioned other points relating to this subject.

The relative proportion of the various alimentary principles that should be secured in our diets is a wide subject, involving very intricate physiological problems. Some general notions on this head may be gathered by reference to the sections treating of milk and eggs, which we spoke of as typical foods. The tables already given from Parkes and others indicate the most trustworthy conclusions arrived at by those who have scientifically investigated the subject. From these tables, and from what has already been said, it will be seen that no other articles of food besides milk and eggs comprise all the requisite elements in proper proportions. Neither bread alone, nor meat alone, as ordinarily eaten, affords the due combination. Magendie's experiments on the feeding of dogs long ago proved that vigorous health cannot be sustained by white bread alone, although the animals throve well on unbolted whole-meal bread. Bread of this kind, whether made of wheat, oats, or rye, will not only sustain life, but even active laborious life. "The Sicilians, and many of the natives of Southern Italy, live almost entirely on bread or macaroni, which is practically the same thing, made of whole wheaten meal, with a little fruit or other vegetable (important additions), and go through any amount of hard muscular work. The Hindus of North-western India can walk fifty or sixty miles a day with no other food than whole-meal cakes (and a little Galam butter). Turkish and Arab porters will carry burdens of 400 lbs. to 600 lbs., living only on coarse whole-meal bread (and occasionally a few dates or some vegetables). Even in cold northern climes—Russia, Sweden, and Scotland—the poor live almost entirely on some whole-meal food, maintaining a degree of health and physical strength beyond most whose diet is more varied and luxurious."

Man is both a carnivorous and a herbivorous animal. He is also an inhabitant of all regions, and must adapt himself to the wants of his body in varieties of climate and circumstances of life, varying the amount and proportion of the elements of his food accordingly. This both instinct and necessity compel him to do, and it is interesting as well as instructive to note the ordinary diet of the inhabitants of different countries.

We may, for this purpose, select from the extracts given by Dr. Pavy from the works of various authors, some examples of the food consumed by inhabitants of different parts of the globe, illustrating respectively an animal, a vegetable, and a very composite diet.

The Eskimos live chiefly on animal food, there being little or no vegetable to be had, fat being the representative of the carbo-hydrate constituents. Their food consists of the reindeer, musk ox, walrus, seals, birds, and salmon, and they delight in fat and marrow. Dr. Kane, in his Arctic explorations, says :—" Our journeys have taught us the wisdom of the Eskimo appetite, and there are few among us who do not relish a slice of raw blubber, or a chunk of frozen walrus beef. The liver of a walrus (aroaktanak), eaten with little slices of his fat, of a verity it is a delicious morsel. Fire would ruin the curt, pithy expression of vitality which belongs to its uncooked juices. Charles Lamb's roast pig was nothing to 'aroaktanak.' I wonder that raw beef is not eaten at home. Deprived of extraneous fibre, it is neither indigestible nor difficult to masticate. With acids and condiments, it makes a salad which an educated palate cannot help relishing, and as a powerful and condensed heat-making and antiscorbutic food it has no rival.

" I make this last broad assertion after carefully testing its truth. The natives of South Greenland prepare themselves for a long journey in the cold by a course of frozen seal. At Upernavik they do the same with the narwhal, which is thought more heat-making than the seal; while the bear, to use their own expression, 'is stronger travel than all.'

" In Smith's Sound, where the use of raw meat seems almost inevitable, from the modes of living of the people, walrus holds the first rank. Certainly this pachyderm, whose finely-condensed tissue and delicate permeating fat—oh ! call it not blubber—assimilate it to the ox, is beyond all others, and is the very best food a man can swallow. It became our constant companion whenever we could get it, and a frozen liver upon our sledge was valued far above the same weight of pemmican."

In the selections from Humboldt's works relating to Mexico, we read that "The Indians of New Spain, those at least subject to European domination, generally attain to a pretty advanced age. As peaceable cultivators and inhabitants of villages, they are not exposed to the accidents attending the wandering life of the hunters and warriors of the Mississippi and of the Savannas of the Rio Gila. Accustomed to uniform nourishment of an almost entirely vegetable nature—that of their maize and cereal gramina—the Indians would undoubtedly attain very great longevity if their constitutions were not weakened by drunkenness. Their intoxicating liquors are rum, a fermentation of maize, and the root of the jatropha; and especially the wine of the country, made of the juice of the *Agave Americana*, called 'pulque.' This last liquor is nutritive, on account of the undecomposed sugar which it contains. Many Indians addicted to 'pulque' take, for a long time, very little solid nutriment. When used with moderation it is very salutary, and, by fortifying the stomach, assists the function of the gastric system."

Again, of these same people, Dr. Lyon says :—" The usual food of the labouring classes, throughout such States as I visited, is the thin cake of crushed maize, which I have described under the name of tortilla; and it is remarkable that, notwithstanding the great abundance of cattle in many places, the traveller can scarcely obtain meat in the little huts which he finds on his road. Chillies are eaten abundantly with the tortillas, being stewed in a kind of sauce, into which the cakes are dipped. A few fowls are at times to be seen wandering near the cottages, or some pigs rambling through the village, and the flesh of these creatures furnishes a feast on holidays."

In striking contrast to these accounts of the diet of the Mexican Indians, we find Sir Francis Head, speaking of the Pampas Indians, saying :—" They are all horsemen, or, rather, pass their lives on horseback. In spite of the climate, which is burning hot in summer and freezing in winter, these brave men, who have never yet been subdued, are entirely naked, and have not even a covering for their head. They live together in tribes, each of which is governed by a cicique, but they have no fixed place of residence. Where the pasture is good, there are they to be found, until it is consumed by their horses, and they then instantly move to a more verdant spot. They have *neither bread, fruit, nor vegetables,* but they subsist entirely on the flesh of their mares." Describing the effect on himself of this diet, Sir Francis says :—" After I had been riding three or four months, and had lived on beef and water, I found myself in a condition which I can only describe by saying that I felt no exertion could kill me. Although I constantly arrived so completely exhausted that I could not speak, yet a few hours' sleep upon my saddle on the ground always so completely restored me that, for a week, I could daily be upon my horse before sunrise, could ride till two or three hours after sunset, and have really tired ten or twelve horses a day. This will explain the immense distances which people in South America are said to ride, which I am confident could only be done on beef and water."

The Guachos of the Argentine Republic live entirely on roast beef and salt, scarcely ever tasting farinaceous or other vegetable food, and their sole beverage is Maté or Paraguay Tea taken without sugar.

" The Chinese," says Sir John Bowring, " have no prejudice whatever as regards food; they eat anything and everything from which they can derive nutriment—(dogs, rats, mice, monkeys, snakes, sea-slugs, rotten eggs, putrefied fish, unhatched ducks and chickens). Both in eating and drinking they are temperate, and are satisfied with two daily meals—the morning rice about 10 a.m., and the evening rice at 5 p.m. The only repugnance that I have observed in China is to the use of milk. I never saw or heard of butter, cream, milk, or whey being introduced at any Chinese table."

Japan and the adjoining isles abound in articles of food, and the diet of the inhabitants is very varied and complex. Their rice, which is very good, takes the place of bread, and is eaten boiled with every kind of provision.

" Miso soup, boiled with fish and onions, is eaten by the common people, frequently three times a day. Misos are seeds of the *Dolichos Soja,* not unlike lentils.

There are several varieties of the soy bean known in the East largely consumed as food, and now exported as "soy." In its constitution the soja, or soy, is said to approximate more nearly to animal food than any other vegetable, being very rich in fat and albuminates. It is therefore a valuable adjunct to the food of many of the Japanese, who are mainly vegetarians.

"Fish is likewise a very common dish with the Japanese, both boiled and fried in oil. Fowls, of which they have a great variety, both wild and tame, are eaten in great abundance, and the flesh of whales, though coarse, is in several places among the poorer sort a very common food.

"In preparing their victuals, they make a very plentiful use of mushrooms and the fruit of the 'egg apple,' as well as the roots of the 'Solanum esculentum' (*batatas*), carrots, and several kinds of bulbous roots, and of beans."*

From these examples it will be seen how widely the dietaries of various tribes of men differ—how largely either animal or vegetable food may preponderate and be consistent with health and vigour. Herbivorous animals, such as the horse and the ox, show how great muscular power and capacity for work may be secured by a purely vegetable diet, comprising the requisite amounts of nitrogenous and non-nitrogenous principles. And there can be no doubt that men may be capable of continuous hard work and live solely on vegetable food. On the other hand, there is abundant evidence to show that the generality of men thrive best, and are best fitted for all varieties of work, whether mental or bodily, and for all the varied circumstances of life, on a mixed diet of animal and vegetable food.

A flesh diet is considered to be more stimulant than a vegetable diet, and to render the blood richer in red corpuscles, whilst it tends less to the formation of fat, and so to increase of weight. It is on this principle that what is called "Bantingism" is founded, the object of which is to keep down the formation of fat, by abstaining as far as possible from those constituents which most abound in vegetable food, and are most readily converted into fat. A diet, consisting too much of animal food, acts, however, prejudicially in other ways, and in persons of certain constitutional tendencies is often productive of great mischief by over-stimulating those organs which are called to relieve the system of effete matter. What is called the more sustaining effect of a meat meal, the greater feeling of satisfaction that it occasions, is probably due to the more speedy conversion into nutriment, and appeasing of the sense of hunger. The evils arising from excess of animal food are most marked in persons leading a sedentary and luxurious life, and are counteracted by active bodily exercise. But the evils arising from excess of food, whether animal or vegetable, are legion.

Most persons have been conscious of cold or chilly feelings and torpidity when greatly in need of food, and are aware that an increased temperature of the body is a sign of fever. In the former case, there is need of the proper amount of fuel to sustain the animal heat, and in the latter, the tissues of the body are being burnt up too rapidly by the excited and deranged action induced by disease. A falling of temperature is one of the earliest effects and signs of deficiency of food, which, if continued, leads to starvation and death. The genial warmth of which a tired and hungry man is conscious after allaying his hunger by a sufficient meal is one of the first effects of supplying what the system needs to keep up the temperature of health. Death from starvation, it is well known, may be retarded or avoided if by external warmth, by means of clothing, shelter, and fire, the temperature of the body can be sustained till food is obtainable. Hence, in times of scarcity, the sufferings and privations of the poor are greatly mitigated if they be provided with fuel and shelter.

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* Thurnberg's Travels, 1795.

Public attention, not long ago, was greatly excited by the daily reports of an eccentric American, who professed to show that he could live without food for forty days. The average time that life can be sustained under entire abstinence from food and drink is said to be from eight to ten days, but will vary according to the attendant external circumstances, and according to the amount of fat or other combustible material present in the body. The Welsh fasting girl of 1869 died on the eighth day, after being subjected to strict watching in order to detect her imposture. During this time the temperature of her body gradually fell, and she became torpid and unconscious, and could not be roused. The phenomena observed in shipwrecked mariners and others who have perished from starvation are too harrowing to be detailed here. One of the first symptoms is severe pain at the pit of the stomach, for a time relieved by pressure, as by binding a cord round the body; and the ultimate effects are manifested by the brain and nervous system in torpor, stupidity, or raving delirium, and by extreme emaciation. In all cases where abstinence from food has been prolonged, when it is again taken, it should be given with great caution, in small quantities at a time, at short intervals, and of the kind most readily digested and absorbed.

But the evils arising from deficiency of food, except among the poor, are more frequently seen in connection with the deficiency of particular elements, occasioned either by the perverseness or fanaticism of the sufferers, by ignorance, or by accidental circumstances. One of the most typical examples of scurvy that ever came under the notice of the writer was in a woman, who, from fear of cholera, had resolutely abstained from all vegetable food for some months, and by the proper supply of which, without other treatment, she recovered from day to day. The imperfect nourishment and sickliness of children are often traceable to some such cause. But in these and similar cases it is the part of the physician to detect the cause and indicate the remedy.

The constant presence of salt in the blood and the secretions shows the necessity of a due supply of this substance. The want of it will occasion serious consequences. In barbarous times culprits were sometimes condemned to a diet entirely devoid of salt, and died in consequence a horrible death.

The oxides of iron, which are important to the processes of sanguification and oxidation, may be so deficient in the food as to lead to well-known diseases, characterised by a bloodless aspect, shortness of breath, and debility.

A great aversion to fat and oils is not a healthy sign, and any considerable deficiency of these leads to disease. On the other hand, when in excess, there is too great a tendency to fat formation, which is also promoted by saccharine substances, by farinaceous foods, and such fermented liquors as beer and porter.

Any marked and long-maintained disproportion in the different constituents of food leads to disease. Fortunately, instinct, rather than science or custom, teaches us, for the most part, the necessity for maintaining the proper adjustment.

Digestibility of Food.—On this head enough has, perhaps, already been said, when describing our various alimentary materials, and under the head of preparation of food. A few words in addition may, however, be desirable, inasmuch as for all persons, whether of strong or weak digestion, it is important to make that selection of food which is most readily and completely digested; and when economy is of importance, this is still more requisite.

Much valuable information on this subject has been obtained from experiments on various foods submitted to the action of artificial gastric juices in bottles, and still more from the prolonged observations made by Dr. Beaumont on a Canadian with a permanent fistulous opening into the stomach, by which food could be introduced and removed from the stomach at various intervals. It must be remembered, however, that in all these experiments and observations we are only informed on that part of the digestive process which is performed in the stomach, whereas there are other steps in the process which take place after the food has passed out of the stomach. We have also to bear in mind that different degrees of nervous and vascular power, varying states of mind as well as of body, influence the digestion in most important ways, as also does the kind of previous cooking.

The results of Beaumont's observations on Alexis St. Martin, as given by Parkes, are as follows:—" Rice, tripe, whipped eggs, sago, tapioca, barley, boiled milk, raw eggs, lamb, parsnips, roasted and baked potatoes, and fricasseed chicken, are the most easily-digested substances in the order here given, the rice disappearing from the stomach in one hour and the fricasseed chicken in 2¾ hours. Beef, pork, mutton, oysters, butter, bread, veal, boiled and roasted fowls, are rather less digestible, roast beef disappearing from the stomach in three hours and roast fowl in four hours. Salt beef and pork disappeared in 4¼ hours." As a rule, Beaumont found animal food digested sooner than farinaceous, and in proportion to its minuteness of division and tenderness of fibre.

" The admixture of different classes of food aids digestibility; thus, fat taken with meat aids the digestion of the meat. Some of the accessory foods probably increase the outpour of saliva, gastric juice, or enteric juice, &c.

" The degree of firmness and division of food, the amount of solidity and of trituration, which should be left to the teeth, in order that the fluids of the mouth and of the salivary glands may flow out in due proportion, the bulk of the food that should be taken at once—are points which, though seemingly slight, are of real importance. Another matter which appears to affect digestibility is variety of food."

It is not enough to give the proximate dietetic substances in proper amount. Variety must be introduced into the food, and different substances of the same class should be alternately employed. No doubt many men, as well as most animals, thrive well on a very uniform diet. But sameness cloys the appetite, and more nutriment may be taken with variation in the diet. This is practically done by variety in the cooking, which, even in the case of children, has been proved to be very advantageous.

Some other circumstances of no mean importance, as influencing digestion, will be better noticed under the next head, viz. :—

REGULARITY, AMOUNT, AND FREQUENCY OF MEALS.

If on these points we should seek to be guided by the example of animals, prompted by instinct only, or even by savages, or man in a state of nature, as some would say, we should perhaps find it difficult to deduce rules for our own guidance. Nor should we, without careful consideration, be much helped if we merely looked to the prevailing habits of different nations and classes of people. Among civilised people the circumstances of life are so various that there must inevitably be great diversities of practice in reference to the time and frequency of taking food. Our physical constitution, happily, is such that, when guided by reason, we can adapt ourselves in a marvellous degree to our circumstances and the claims of our various callings in life. We are all of us also creatures of habit, which at length becomes to us a second nature, and enables us to pursue paths deviating widely from those which science would dictate.

The habits of carnivorous and herbivorous animals differ greatly as to their taking of food. The mode of existence of the carnivora entails great irregularity in the times of feeding and long intervals of abstinence. Their living may be said to be precarious, and they must watch their opportunity for securing a meal. When obtained, it is ravenously devoured, and, if the supply admits, taken to the utmost repletion, when the ensuing torpor leads to rest and sleep.

The savage, in like manner, when his food is abundant, eats till he can eat no more, and sleeps to eat again on waking. If game be scarce, the fields bare or covered by snow, he must be content with scanty meals at long intervals.

The amount which some savages will devour at one meal is enormous. Barrow, in his account of "Travels in the Interior of South Africa," says of the Hottentots :—"Ten of them ate in his presence an ox, all but the hind legs, in three days; and three Bosjesmen that accompanied his wagon devoured a sheep on one occasion in less than twenty-four hours." "But the most marvellous account of gluttony," says Letheby, "is given by Captain Cochrane, on the authority of the Russian Admiral, Saritcheff, who was told that one of the Yakuti had consumed the hind-quarter of a large ox in twenty-four hours, together with 20 lbs. of fat and a proportionable quantity of melted butter. To test the truth of this, he gave him a thick porridge of rice, boiled down with 3 lbs. of butter, weighing together 28 lbs. Although the glutton had already breakfasted, yet he sat down to the meal with great eagerness, and consumed the whole without stirring from the spot, and, except that his stomach betrayed more than ordinary fulness, he showed no signs of inconvenience. Captain Cochrane further adds that a good calf weighing 200 lbs. will just serve for a meal for four or five Yakuti, and that he has himself seen three of them consume a reindeer at a meal." Livingstone's account of the appetites of many of the tribes that he came across in Africa accords with Barrow's statements, and the reports of the feeding of his Zulu Majesty whilst among us is in a measure corroborative.

Herbivorous animals, whose food is always within reach, may be said to be constantly feeding, with but short intervals of rest. Some, however, as horses, are capable of going many hours without food, even when at work, although this is not found to be conducive to health and vigour. The Arabs allow them small quantities of concentrated food at moderate intervals.

The tendency at the present day among civilised people is to take frequent meals in the day. In former times this was not the custom. Among the Romans there were but two meals a day—breakfast, as we should say, but what they called "prandium," or dinner, about nine o'clock, which was an unceremonious repast, taken standing, and usually without wine; and supper, or "cæna," which was the chief meal, taken about three or four o'clock in the afternoon. In France and many parts of the Continent the custom is even still practically the same, although a cup of chocolate or a piece of bread, with perhaps a little fruit, is taken soon after rising, the breakfast at eleven or twelve, and the dinner at five or six o'clock. With us also there are many who take only two meals—breakfast of a substantial character, and dinner late in the day. There are but few imitators of Dr. Fordyce, one of the physicians and chemical lecturer at St. Thomas's Hospital in the last century, who, by consideration of the habits of carnivorous animals, and his own chemical and physiological studies, came to the conclusion that only one meal a day was either necessary or desirable; and the following is said to have been his usual daily mode of dining:—"At four o'clock in the afternoon he presented himself at 'Dolly's Chop House,' and took his seat at a table reserved for him. Immediately on his arrival, the cook would place a pound and a half of rump-steak upon the gridiron, and while it was cooking the doctor would amuse himself with some such trifle as half a boiled capon, or a plate of fish, and a glass or two of brandy, his regular allowance being a quarter of a pint. Then came the steak, with a full accompaniment of bread and potatoes, and it was always served with a quart tankard of strong ale. This was followed by a bottle of old port; and when the dinner was finished, as it invariably was in an hour and a half, he walked leisurely to his rooms in Essex Street in the Strand, where he met his class, and gave his lecture on chemistry." How far this worthy doctor induced his pupils or his patients to follow either his precepts or his practice, we are not told. Certainly, most people would be unfitted for either mental or bodily work directly after such a meal, even without the brandy or port wine, whatever might be their capacity for work and business on the following day.

The present more usual practice of three meals a day has good reason, as well as custom, in its favour. When work of any kind is being done, whether mental or bodily, the intervals between taking food should not be so long as to entail demands on the system when its store of material for the generation of force is exhausted. An ordinary full meal, in a healthy man, is generally considered to have been completely digested and passed out of the stomach in the course of four hours. A period of rest should then be granted to the stomach. Assuming that two hours are allowed for this, the interval between one meal and another would be six hours. And this accords with the experience of most men. During rest and sleep there is less waste going on, and especially during sleep there is a greatly diminished activity of all the functions of the body. The interval, therefore, between the last meal of one day and the first of the next may be longer, as it generally is, than between the several day meals. In the morning, the longer interval of abstinence that has transpired, the freshening effects of sleep, and the morning's bath, prompt to the taking of a substantial meal; an additional reason for which is found in the necessity for laying in a store of energy preparatory to entering on the occupations of the day. In a natural and healthy state of body, there is a readiness and appetite for food at breakfast time. There is something wrong when this is not the case: over-indulgence on the previous day, or an over-exhausted state of system, or it may be, the first indication of the ill-effects of intemperate habits, leading the tippler to call for his dram or "pick me up" to enable him to take food, which perhaps he is aware he requires. It must, however, be admitted that there is considerable difference in different persons as regards appetite for breakfast. Habit and custom have their influence. This, however, is certain, that if active bodily exercise is to be taken, it should not be entered on before laying in provision for it by food; and it is the universal testimony of travellers, and of those who live in districts where intermittent and other fevers prevail, that the dangers arising from exposure to their influences are greatly increased by starting for the day without food. A literary man about to enter his study, an indolent man who will loll over his newspaper, or the lady who goes to her sofa with her book or her needlework, may not require anything more than a very light breakfast. Assuming that the breakfast be taken about eight or nine o'clock, there should be a mid-day meal about one or two. The character of this must depend on the nature of the day's occupation and the conveniency of the individual. With women and children, this is generally their hungry time, and the mid-day repast, whether called luncheon or dinner, is the chief meal. So is it with the middle and labouring classes for the most part. But for merchants, professional men, and others, whose occupations take them from home all the day, this is inconvenient. And even where this cannot be said to be so, it is not found conducive to health or comfort to take a full meal in the midst of the day's work. There can, however, be no doubt that much evil arises from attempting to go through the day without food, and then with exhausted powers sitting down to a hearty meal. Something of a light, easily digestible, but sustaining character, should be taken towards one or two o'clock. A little soup, with dry bread or toast—a sandwich and a cup of coffee or chocolate—a slice of mutton, or a cutlet, with bread and a glass of water or of some light wine—a basin of bread and milk, or a rice-pudding—may be selected, according to individual experience of the sort of food that is taken with most comfort, when but little time is allowed for the meal, and when recourse to duty must immediately follow. For many persons, any wine or beer in the middle of the day is undesirable. If more time can be allowed for the meal, or if the active part of the day's work is over, a more complete meal is admissible, and indeed desirable, if the evening meal be not taken till eight or nine o'clock.

The very prevalent custom, in the present day, of taking tea in the afternoon, or before dinner, is not only unobjectionable, but useful to very many people. It is refreshing on coming home tired, and restores nervous energy preparatory to the substantial meal. But it should be only a cup of freshly made tea, that has not been allowed to "brew" long, accompanied only by a little milk, or, if taste so prefers it, a lump of sugar. Let it, however, be remembered that we are not giving counsel to the dyspeptic, and that in every case individual experience must be the guide. Coffee, with many people, is less adapted for the object in view than tea.

The practice of taking tea with a principal meal, or what is called a "meat tea," is not to be commended. Tea does not promote digestion of the food in the stomach, and especially is not adapted to accompany meat, but rather bread and farinaceous articles. "Meat teas," as a daily habit, are more likely to create dyspepsia than not. The proper time for tea is an hour or two after food, or when the stomach is empty.

What is called dinner, among the upper classes, in the present day, would have been called supper by our forefathers, and takes place at even a later hour than the old supper. To this there would be little objection, provided the hour of retiring to rest were correspondingly deferred, and the preceding interval of fasting were not unduly extended. For though a certain period of rest, after a hearty meal, assists the process of digestion, digestion is impeded by continuous sleep, which is pretty certainly made uneasy and disturbed when the stomach has been recently charged with a full meal. Quiet and refreshing sleep is best secured when the wants of the system have been satisfied by a meal in great measure digested, and when the functions of the stomach need no longer be in full activity; but a long fast and repletion are alike hindrances to sleep. If some hours are to elapse before retiring to rest, after the evening meal—call it either dinner or supper—to be spent either in the quiet of domestic life, or in the fatigue and excitement of society, digestion will have been pretty nearly completed before sleep is sought, and no harm ensues from the full meal, assuming that in character and amount it has been in accordance with ordinary prudence and temperance.

How shall we attempt to lay down rules for general guidance in these respects? It is no doubt difficult, owing to the very various circumstances in which our lives are passed. Some leading principles may, however, be stated, which will be found to be of very general application. In the first place, great caution is needed in sitting down to the chief meal of the day, when both mind and body are exhausted by long-continued labour and abstinence. In the next place, a rapid, hurried mode of eating should be avoided, especially if the repast commences with some solid dish. There are advantages in commencing with some light food, such as soup or fish, in small quantities, not calling for the full powers of the stomach, whilst the gastric juice is not in full flow, and when the muscular powers of the stomach partake of the general enfeeblement of the system. It is frequently supposed to be undesirable to commence with fluids, and this is probably the case if any large amount be taken, but not otherwise, in the case of a nutritive fluid like soup, by the gentle stimulus of which the secretions of the stomach are called forth. It is certainly preferable to the glass of sherry or prefatory dram.

We write not for epicures, and therefore say nothing of the "gustus" of the

Romans, the various whets to the appetite in the shape of oysters, sardines, and anchovies, with which elaborate feasts are introduced.

If the meal is to consist principally of one dish or joint as the *pièce de résistance*, it is better not to take this in the midst of a pile of vegetables of all kinds, but with some single vegetable, if bread or macaroni or rice be not preferred, and let the broccoli or spinach, if not the potato, form a separate dish, cooked in its own proper way. If some light pudding, or a little stewed fruit, follow as a separate course, sufficient admixture will have been secured both to satisfy dietetic requirement and the need for variety. But there will generally be no objection to a fragment of cheese and biscuit, or dry toast, as a supplement We will not touch here on the question of wine or beer, save to say that if the latter be taken it comes best at the close of the meal. During the meal, if water suffice not, a glass of claret, with an equal part of water, should content most people. In France, where nothing but the light wines of the country are taken at meals, these are always diluted (*coupé*) with water, and great surprise is felt at our English custom of taking even claret pure at dinner, and much more in the case of our stronger fortified wines, such as sherry.

It falls not within our sphere to describe the elaborate feasts of the present luxurious times, nor to give a variety of "ménus" for modern establishments. We content ourselves with sketching the sort of repast that comprises all that is necessary, and which may be varied from day to day, both in kind and mode of cooking, without incurring either unnecessary expenditure, or the risk of a surfeit. A much simpler meal will satisfy many people, who will dine off a mutton chop and a potato, day after day, without complaint or desire of change. On the other hand, in the most economic households it is quite possible to introduce various little trifles, both wholesome and appetising, that will serve to help a capricious appetite, and quiet a discontented spirit.

The quantity needed to satisfy either the appetite or the requirements of the system it is manifest will vary greatly with the eater, according to age, sex, occupation, &c. So in like manner should the relative proportion of animal and vegetable food. The principles already stated in reference to the necessity for securing a due proportion between the various alimentary principles must ever be borne in mind, and especially in the case of growing children.

A certain degree of regularity in the times of taking food is, in many ways, important. The force of habit in this respect is often very marked. The desire for food in many cases occurs with all the regularity of the clock; and, what is more remarkable, if it be not satisfied at the accustomed hour, the appetite vanishes, and the food, when presented at the unusual time, is taken unwillingly, and perhaps is followed by indigestion. This "over-staying" the appetite, as it is called, is a matter of real importance to weakly people or dyspeptics; but it is manifestly undesirable to be too much under the influence of habit if it can be avoided, although great irregularity in the times of feeding is liable to prove injurious to most persons in the long run. What may be done with impunity in full health and vigour may ultimately be followed by detriment.

If the late dinner or supper be the chief meal of the day, nothing should be taken afterwards but a cup of tea or coffee. Either the one or the other, according to individual experience, will generally be productive of comfort, and render any sedentary work easier; but some little time should elapse after the meal before tea is taken, and where the tendency of this is to interfere with sleep, it must, of course, be avoided. The custom of taking stimulants of any kind immediately before going to bed is, nine times out of ten, with healthy persons a most undesirable and pernicious practice.

We have shown in preceding pages the different amounts and character of food required, according to the daily expenditure of the system entailed by various occupations and modes of life. The same principles, to a great extent, apply to differences of age. A great deal of the mortality among young children, more especially of the poor, is due to improper feeding, the result of either ignorance and indiscretion, or the dire necessities of poverty. We speak not of infants at the breast, who ought to be restricted to the food provided by nature, but who too frequently are not; various things being given to some infants of a few months old that cannot be otherwise than prejudicial, inasmuch as the digestive system of the infant is not adapted to derive nourishment from anything that deviates much from the constitution of the mother's milk. This is shown by the extreme susceptibility to bowel disturbance, and the innumerable deaths occurring from simple exhausting diarrhœa thus induced.

But the defects and errors in the food of children become still more frequent and serious at the time of weaning, and soon after it, at the transition period, when the child passes from nature's food to artificial. As the organisation of the little one advances, the digestive system acquires power to utilise less simple food, and the appearance of teeth proves that provision is being made to perform the processes which are preparatory to the action of the stomach. But, for some time longer, all articles requiring mastication should be withheld, and the food should still consist of milk and farinaceous articles, the starchy elements of which the child's digestive powers are now capable of dealing with. These, however, should be properly prepared by boiling, with a view of previously rupturing the starch grains, and so presenting them in the state most easily acted on by the stomach. After a time, those farinaceous articles should be selected which are richer in nitrogenous elements, such as baked flour, biscuit-powder, and rusks, rather than arrowroot, tous les mois, &c. Animal food in the solid form should certainly not be allowed till the teeth are capable of dealing with it, although not infrequently the state of the child's nutrition will point to the propriety of associating some animal broth with the farinaceous food. Except in this form, most children are probably better without animal food till past two years of age, light puddings, with eggs and bread and butter, taking its place. At this time a prudent nurse will be somewhat guided by the child's liking or aversion for particular foods. The natural appetite with children as well as adults must be taken to indicate the wants of the system, and should not, therefore, be disregarded. Most children have an instinctive liking for sugar, which may be explained by the fact that it is essentially a respiratory food, and the respiratory function in children is always in great activity. In cold regions where sugar is not to be had, the instinct is still for things rich in carbon and hydrogen, to yield the requisite heat by combustion. In some of the Arctic voyages, the inhabitants were found to be unacquainted with the taste of sweets, and the infant children made wry faces and spat out sugar with disgust, whilst they grinned with delight at the sight of a bit of whale's blubber. In like manner, some children show a decided liking for vegetables, and others for animal food, and suffer in health if compelled to take only the particular diet laid down for them, on the principle that others know best what is good for them, and that they should eat what is given them.

A diet of milk, bread and butter, eggs, and the stronger farinaceous articles should, as a rule, constitute the main food of children till approaching four years of age. And it should be remembered that, in proportion to its weight, a growing child requires a much larger amount of both nitrogenous and carbonaceous material than an adult. The poor will obtain a sufficient supply of these in sound, well-cooked potatoes, salt, and oatmeal, if even bread and milk or butter-milk cannot be obtained. Children also require more frequent meals than adults; they do not so well bear long fasting, and require more sleep. To this they are generally disposed after a meal, and it is desirable that they should be kept quiet for some time after their meals.

As old age approaches, the appetite is generally less keen, the powers of digestion more feeble, the amount of mechanical work performed is less, and the respiratory process feebler. Hence there is generally to be noticed less capability of enduring cold, and a necessity for warmer clothing and artificial heat. All the bodily functions are performed in a more languid manner, and the requirements for food diminished. There is a natural tendency to revert to the diet of childhood, and milk and eggs are again in demand. But although in amount the food in very advanced age should be less, some proportion of animal food is generally desirable, particularly in the form of good soup, with macaroni or vermicelli; and, for the most part, a certain amount of fermented liquor aids the digestion and adds greatly to the comfort of the aged. The well-known case of Cornaro, the Venetian noble, who lived in the 15th century, is the best illustration of health and vigour of both mind and body being retained to an advanced age on a very restricted diet, amounting in weight to no more than 12 oz. a day. This consisted of bread, meat, the yolk of egg, and soup, with which he took 14 oz. of the light wine of the country. He attained to the age of nearly 100 years, in possession of all his faculties, and wrote his several discourses on "The Advantages of a Temperate Life" in his 83rd and subsequent years. Till middle age he had indulged in intemperate habits of eating and drinking and other pleasures, when he fell into ill health as a consequence of these excesses, and became the subject of various disorders that made life a burden. At 40 years of age he was constrained by his physicians to submit to severe regimen and a restricted diet, by which means he soon regained health and strength, freedom from pain and melancholy spirits. At 70 years of age he met with severe injuries from accident, from which it was supposed he could not recover. He, however, was restored speedily to his usual health. His treatises have been translated into almost every European language, and were for a long time very popular, leading many to adopt his system.

The celebrated Caius, founder of Caius College, Cambridge, and President of the College of Physicians, who wrote on the "Sweating Sickness," an epidemic which ravaged England and carried off thousands of its inhabitants in the middle of the 16th century, in his declining age sought to sustain his failing powers by resorting to the food of infancy. And many have advantageously followed his example as regards its principle, though not as to the mode in which he carried it out; for he not only resorted to the food of infancy, but also to the infantile mode of imbibing it. His treatise to which reference has been made was the first sanitary essay published in this country, and is full of sage advice and evidence of shrewd observation, denouncing the gluttony of his times and the irrational diet. On the subject of preservation against the epidemic, he says, "Who that lustethe to liue in quiete suretie, out of the soudaine danger of this Englishe ephemera, he above all thynges, of litle and good, must eate and spare not, the last parte whereof wyl please well (I doubt not) Englishemen; the firste I think never a deale."

If we take as correct the account of Caius' experience in old age in respect of the different effects of milk from different sources, it evidently confirms the correctness of the common observation, that it is important when infants are fed on cow's milk that it should be derived from the same animal, and care be taken to select a cow whose milk agrees best with the child. It is even important to see that the food of the particular cow selected should vary as little as possible.

It does not come within the scope of this article to speak of the particular diets adapted to those conditions of system which deviate from the healthy state. Nevertheless, a few words may here be said on the effect of certain foods on persons who are disposed to become too corpulent, and on what has of late been described as "Bantingism." The main principles involved in this subject have already been illustrated when speaking of the effects of various foods as fat producers. These effects have been known and described by old authors from the time of Hippocrates, long before science had discovered their rationale. The Greeks and Romans and oriental nations knew that fats, sweets, and farinaceous articles led to the formation of fat and increase of the weight of the body, and held correct opinions on the dietetic principles requisite for athletes and others in whom it was wished to increase hard muscular fibre and capacity for activity and endurance. It was by adopting the old Hippocratic rules that Mr. Banting succeeded in his resolute efforts to keep down his rapidly-increasing bulk and weight from excessive obesity. The daily diet by means of which he accomplished his purpose he thus describes:—"For breakfast, at 9 a.m., I take 5 oz. or 6 oz. of either beef, mutton, kidneys, broiled fish, or cold meat of any kind, excepting pork or veal; a large cup of tea or coffee, without milk or sugar; a little biscuit or 1 oz. of dry toast; making together 6 oz. of solid and 9 oz. of liquid. For dinner, at 2 p.m., 5 oz. or 6 oz. of any fish except salmon, herrings, or eels; any meat except pork or veal; any vegetable except potato, parsnip, beet root, turnip, or carrot; 1 oz. of dry toast; fruit out of a pudding not sweetened; any kind of poultry or game; and two or three glasses of good claret, sherry, or Madeira; champagne, port, and beer forbidden; making together 10 oz. or 12 oz. solid and 10 oz. liquid. For tea, at 6 p.m., 2 oz. or 3 oz. of cooked fruit, a rusk or two, and a cup of tea without milk or sugar, making together 2 oz. to 4 oz. solid and 9 oz. liquid. For supper, at 9 p.m., 3 oz. or 4 oz. of meat or fish, similar to dinner, with a glass or two of sherry and water or claret, making together 4 oz. of solid and 7 oz. liquid. For night-cap, if required, a tumbler of grog (gin, whisky, brandy, without sugar), or a glass or two of claret or sherry. And this plan," he says, "leads to an excellent night's rest with from six to eight hours sound sleep." If this diet be compared with the table given on page 161 of the proportion between nitrogenous and non-nitrogenous food necessary for active life, it will be seen that there is a large deficiency of carbonaceous matter. Mr. Banting has maintained his health on this diet, and succeeded in keeping down his weight below 11 stones, instead of 14½ stones. But though the principle here adopted is doubtless sound, the details are open to criticism, and it cannot be taken as an example to be followed in its entirety by all persons who may wish to keep down a tendency to excessive corpulency. For one thing, the amount of wine and spirits is far too great to be generally admissible. Nor should any such plan be had recourse to suddenly, or persevered in with too great strictness without watching its effects on the general health and strength. Sugar, in all its forms, appears to be the one element that should most strictly be avoided; and next to this butter and farinaceous articles, including bread, which should be partaken of very sparingly, giving preference to whole-meal bread or brown biscuits.

We have already said that the amount of fluid required by different constitutions varies considerably. The occupation, amount of physical exercise, temperature of the air, and character of the food, must all be taken into consideration when estimating the amount of fluid required. In active bodily exercise, the loss of the skin is considerable, whilst in cold weather, and when the body is inactive, there is more elimination from the kidneys. In transport ships the amount of water allowed to each person for cooking and drinking is eight pints within and six pints out of the tropics. Women drink rather less than men, and children more in proportion to their weight. If from three and a half to five pints is enough for an adult living on an ordinary diet of meat, bread, &c., 20 oz. to 30 oz. of that quantity will be comprised in the solid food; and if the diet consists largely of fruits and vegetables, there will be still more, and the less need for fluid in a separate form. Persons who, while living luxuriously, are likely to lead an inactive life, accumulate within the system effete matters which, if not excreted, lead to disorder and ill health. Such dangers are obviated by the free drinking of simple fluids, by which the skin, and kidneys, and all the eliminating organs are assisted in carrying off deleterious matters, and thus upholding healthy nutrition. It is a vulgar error to imagine that the free use of fluids tends to favour dropsical affections. The reverse is the case. The free use of fluids, or of vegetables and fruits containing a large amount of juices, is generally advantageous to those who are liable to urinary derangements. Much of the benefit derived from active bodily exercise out of doors, and in warm weather experienced by the inhabitants of crowded cities as the result of their summer holiday, is attributable to the free elimination that takes place by the skin and kidneys in connection with the larger proportion of fluid, mostly water, that is then desired and consumed.

THE INFLUENCE OF STIMULANTS AND NARCOTICS ON HEALTH.

By T. Lauder Brunton, M.D., D.Sc., F.R.S.
Assistant Physician to St. Bartholomew's Hospital.

Introductory—The Value of Alcohol as a Food—The Effects of Alcohol—The Causes of Intemperance—Forms of Alcohol—Diseases Resulting from Excessive Use of Alcohol—Hereditary Effects of Alcohol—Alcohol in its Relations to Crime, Lunacy, and Pauperism—Ether—Opium—Chloral—Indian Hemp—Tobacco—Betel-nut—Tea—Coffee—Chocolate—Cocoa—Guarana — Cola-nut—Coca—Kava—Beef-Tea.

In nearly every country of the world, and among all races, excepting the most savage, we find that the practice of taking certain substances which cannot be regarded as food, but yet afford enjoyment to the consumers, is almost universal. Even the most savage races, who are unable to obtain such substances for themselves, possess a liking for them, which they show as soon as they get an opportunity of obtaining them. These substances are at first sight very various in their nature, but on examination are found to resemble one another in many respects.

They may be classed into stimulants and narcotics. By stimulants, we mean those things which seem to increase our vital powers for the time being, and thus to give us feelings of greater strength or comfort. By narcotics, we mean such substances as lessen our relationship with the external world. When used to a slight extent, narcotics simply afford pleasure by lessening the restraining or depressing effect which external circumstances exert upon the individual. Small quantities thus allow freer play to fancy, and produce a joyousness and thoughtlessness like that of a child whose animal spirits have not been depressed by the wear and tear of life; but in large quantities they abolish all the mental faculties, and render the person who has taken them completely torpid, and incapable of any voluntary thought or action. The effect of such powerful substances as these, both on individuals and communities, is necessarily enormous, and their abuse may lead, not only to individual, but also to national disaster.

The most important of these stimulants are alcohol—in its various forms of wines, spirits, and beer—tea, coffee, and cocoa. The most important narcotics are, alcohol again, in its different forms, tobacco, opium, chloral, and Indian hemp. Besides these, there are a few others, such as coca, amanita, and datura, the use of which is not so general. From this enumeration it will be seen that the stimulants and narcotics are connected by alcohol, which comes into both categories; and, indeed, most of the narcotics are stimulants when given in small doses, although the converse is hardly the case, and we can scarcely say that all the stimulants are narcotics when given in large doses. In order to understand the relationship, as well as the differences, between stimulants and narcotics, it will probably be best to consider, first, the way in which alcohol acts upon the human body, and afterwards to compare its action with that of opium, tobacco, tea, coffee, &c.

Alcohol and its Effects.

At first sight, it appears very odd that men should put into their mouths a poison which may steal away their brains; but for such an universal custom there must be some powerful cause. When we proceed to ask—Why do men do it? we find ourselves at once face to face with the still larger question—Why do men do anything? And to this we must answer, that men do things either to obtain pleasure or to avoid pain. Nor are those motives confined to men alone; for the obtaining of pleasure and the avoidance of pain are, so far as we can ascertain, the great motives of all action in the lower animals as well. These motives are closely connected with the health and welfare of the individual; and without them, individuals would die and the race would perish. The feeling of pleasure is associated with those acts or conditions which are beneficial to the individual or to the race, and pain with those which are hurtful. The feeling of pleasure is often a sufficient incentive to actions which are necessary for the individual's welfare, but Nature has so arranged it that when the desire for pleasure is disregarded, the feeling of pain succeeds as a further stimulus to drive the creature on to the necessary action. Thus, in most persons and animals, the pleasure which is associated with the gratification of the appetite induces them to take the food necessary to sustain life; but if this call be not attended to, the pains of hunger succeed to simple appetite, and drive the person or animal to endure the greatest fatigue, or to brave the greatest dangers, in order to satisfy the wants of nature. The same is the case with drink, which is even more necessary to life than food; and while slight degrees of thirst afford pleasure through the delicious sensations experienced in quenching them, their greater degrees are among the most intense torments which it is possible to endure. But dreadful though pain may be to the sufferer, it is in itself beneficial, by giving warning against those conditions which would be injurious, and by inducing the individual to avoid them. The effect of its absence is sometimes seen in maniacs, in whom the sense of pain is lost, and who consequently will sometimes thrust their hands into the fire, and will watch with delight their blazing fingers; while a healthy child, when once burned, dreads fire, and so avoids the destruction which the maniac courts.

Of pleasure and pain, then—the two great stimulants to action—the one, pleasure, is closely associated with the well-being or health of an individual; the other, pain, is so closely connected with ill-health, that we usually give the name "disease," or want of ease, to that condition. But all pleasure is not summed up in meat and drink, and so we must try to examine more closely still into the conditions of pleasure. We will find ourselves aided in this attempt by considering the phrases in which the common experience of mankind has translated pleasurable sensations into language. Some of the most common expressions are—"His heart beat high with hope," "His pulses throbbed with joy," "A thrill of pleasure shot through his veins." In all these expressions we see that pleasure and pleasurable sensations are closely connected with the increased activity of the heart and circulation; and this, again, is one of the conditions of health and strength. Even meat and drink, pleasure-giving though they may be, only give strength when they have been converted by the subtle chemistry of the body into blood, and are carried by the circulation to every part of the system; for the food we eat does not go directly to the brain, to supply the waste occasioned in it by the thoughts, fancies, desires, emotions, and will, of which it is the organ; nor does it reach directly the muscles of the arms and legs, to give them the strength for long-continued work: it only reaches them through the blood-vessels. It is from the blood that the brain, the muscles, and every part of the body, derive the nourishment appropriate to each. Huxley well compares the blood to a stream running through a village, from which every individual may take as it passes him (but only opposite his own door) those things which he needs, and cast into it all the refuse which he wishes to be carried away. The stream is the blood, its bed is the vessels, and the inhabitants of the village are the various parts of the body. If from any cause the course of this stream should be languid, the inhabitants of the village would suffer proportionately; and if it should be completely dried up, they would necessarily perish. Nor would the condition be altered in the least if supplies to any amount of the things which they required were accumulated at other points in the stream, so long as it failed to bring them to their doors. It is only as the blood passes through the tissues themselves that they are able to receive nutriment from it, and discharge into it the waste products of their functional activity; and when the blood ceases to pass through them, they perish. It makes no difference to them that the supplies of nutritive material may be in other parts of the body, so long as these are not brought to them by the blood. Increased activity of the circulation brings to the tissues increased supply of blood, enables each tissue to perform its function more easily and more perfectly, and thus conduces to the welfare of the individual, increases his strength and powers, and at the same time gives him sensations of pleasure. The increased nutrition betrays itself in the man's appearance: the blood mantles more richly in his cheek, giving it a ruddier hue, and the increased power of his nerves and muscles renders his step free and his head erect. Pleasure gives power, and power gives pleasure. The success of an army in a skirmish gives them pleasure, and the pleasure gives them power, not only to attack the enemy more vigorously in the next battle, but to resist the ravages of disease. Painful sensations, on the other hand, are associated with a depression of the circulation. The common experience of mankind has embodied this fact also in language. We hear of men's hearts failing them for fear, and of their hearts sinking within them from painful news. Painful impressions, physical or mental, weaken the pulse, and severe physical injuries or mental shocks may stop the heart completely. Pain evidences itself in the appearance and actions. A weakened circulation causes the brain and the muscles to be more imperfectly nourished; the cheek becomes pale, the mental faculties are dull, the step is languid and feeble, and the head is bowed down. Just as pleasure gives power, and power gives pleasure, so pain and sorrow give weakness, and weakness gives pain and sorrow. Soldiers are not only rendered ashamed and sorrowful by defeat, but they are actually weakened, so that they are not only able to resist less perfectly a second attack of their enemies, but are more likely to succumb to sickness and disease. We see, then, that pleasure and power go together with an active circulation of the blood, and that pain and weakness are associated with a languid circulation; that pleasure strengthens the circulation, pain and sorrow depress it. We see also that, on the other hand, if we can strengthen the circulation, we produce pleasure or diminish pain; and if we diminish the circulation, we lessen pleasure and may cause pain. We ought, perhaps, more appropriately to say nutrition than circulation, inasmuch as there are certain exceptions to the statement which we have just been making; but, for the present, we may leave these exceptions aside.

Food and drink increase the strength of the circulation; or, in other words, they stimulate it. The effect of this stimulation makes itself evident not only in the pleasure which is felt from the gratification of the appetite, but in the more cheerful view which the person is likely to take of things in general after a good meal. The effects of a depressed circulation are seen in the gloomy view of things which one is apt to take if weakened by long fasting, or still more if affected with nausea from a sea-voyage, or with the condition which the Greeks so wisely associated with bile in giving to it the name of "melancholy." A vigorous circulation produces or increases pleasure, and diminishes the effect of such external circumstances as cause pain or sorrow. On the other hand, a feeble circulation tends to cause pain, mental or bodily; it aids the action of depressing external circumstances, and lessens the effect of favourable externals to produce pleasure. Such being the case, we would naturally expect not only human beings, but the lower animals, to obtain by all means in their power a vigorous circulation, and to seek after the conditions which favour it; and such is actually the case.

It must not be forgotten, however, that the brain is the organ of the mind and the seat of thought and sensation. Vigorous circulation in it may, to some extent, produce a similar effect to increased circulation through the body generally, and thus substances which increase the circulation in it may become most powerful and useful stimulants, although their action on the general circulation is very slight.

One of the most powerful stimulants to the circulation with which we are acquainted is heat, and one of the most powerful depressants is cold. Exposure to long-continued cold will make the heart beat more feebly, until at last it stops altogether; although a temporary exposure of the surface of the body to a cool breeze or to a dash of cold water may actually increase the circulation, and cause strength and pleasure. Active exercise also increases the circulation, and gives pleasure, although when carried to the extent of fatigue it may render the pulses languid, and produce discomfort or pain. Light is another stimulant to the circulation; and although it is now many centuries since a writer observed that "it is a pleasant thing for the eyes to behold the sun," it is only of late years that the way in which light acts upon the body has been even partially investigated. Throughout the whole animal kingdom we notice the tendency to seek the conditions favourable to the circulation—to rest in a cozy nook by the fire or bask in the sun's rays; to frisk and gambol about while young, and to run, to chase, to struggle, to fight, in middle age. Among human beings who have become too old for such exercises, or are prevented by social obligations from indulging in them, we still find the tendency to seek excitement in the mimic struggle of a game of whist or chess, or in the sympathetic emotions excited by a novel or the stage. All the things just mentioned might be classed as stimulants: indeed, mental emotion is one of the most powerful stimulants that we know. Under the influence of hope, for example, the man or animal who has been wearily toiling for hours over desert sands, and is ready to sink from fatigue, will at once seem imbued with new life, and will hasten to the well which is visible in the distance. But should the well be dry, disappointment and despair at once rob both man and animal of their strength; they throw themselves down in utter exhaustion, and their mental emotions even combine with physical conditions to accelerate their death.

But although all the influences, physical and mental, already mentioned, which increase the power of the circulation, and the nutrition and welfare of the individual, might be classed as stimulants, the name is generally restricted to substances which produce such an effect when they are eaten or drunk, and which cannot be reckoned as food, either because they contain no nutriment at all, or such a minute quantity of nutritious material as to be unimportant. Every action which takes place in the body causes a certain amount of waste; and, indeed, it is only by the combustion of certain materials in our organisms that the mental and bodily energy necessary for our thoughts and acts is evolved. Man and animals have very often been compared to steam-engines, and the comparison is a very good one. Complicated though the mechanism of the steam-engine may be, it is infinitely less complex than that of the animal body; and the comparative simplicity of the engine helps us more easily to understand the workings of the body. In both, the combustion of fuel is the source of movement, and both require their various parts to be repaired when worn out by use. In the steam-engine the fuel is coal or wood, and iron or brass is the material used for repair. In the body the fuel is starch, sugar, fat, and proteids, and some of these substances, along with salts, are also used as material for repair. The body differs from the steam-engine not only in its composition, but in its being steam-engine, stoker, driver, and smith, all in one: it goes, it stops, it feeds itself, and repairs its parts as they are worn out by action. The substances which serve as fuel, or as material for the repair of the body, are foods; stimulants do not necessarily serve either as fuel or as material for repair, although some may do so to a certain extent, and others may lessen the need for food by diminishing the wear and tear, just as a free supply of oil lessens the wear and tear in a steam-engine.

The question whether alcohol is a food is one which has given rise to very great discussion, and has been debated very hotly. If we examine the question dispassionately, we shall probably come to the conclusion that alcohol is a food, although for healthy persons it is not a convenient food. No one doubts that sugar is a food, although few people would ever dream of attempting to live entirely on sugar. If they did try to do so, they would fail, for sugar alone is not capable of supporting life, although it forms a useful addition to other food. A steam-engine might be kept working for a considerable time with coal, but the iron and brass rods and cranks cannot be mended with coal; and if they were worn out, no amount of fuel in the furnace could make the engine go. At the same time, all the metal parts of the machinery might be perfect, but the engine would not go without fuel in the furnace. In the same manner, a man may do a certain amount of work upon sugar as a food, but if he were to take it alone, he would soon die, inasmuch as it would not supply the material necessary for the repair of the body. Nor would an ounce or two of meat and fat be sufficient for daily food, for though it might be sufficient to repair waste, it would not supply sufficient fuel to maintain activity in all the various parts of the body. In the absence of sufficient fuel, the body itself would be consumed and waste away, and death would result. But although the fat, meat,* and sugar would each by itself be unable to support life, the three combined would do so well, and a combination of food, each imperfect in itself, really constitutes a perfect diet. Just as the coal supplied to the steam-engine is burned up in the furnace, passes off from the funnel in the shape of invisible gases, and leaves behind only a small residue of ashes, so do we find that in the animal body the foods which we introduce disappear, and the products of the decomposition are partly given off as carbonic acid by the lungs, and partly by other excretory channels, such as the kidneys, bowels, and skin. But if the coal is mixed with lumps of earth which do not serve as fuel, they do not undergo combustion, and are raked out by the stoker comparatively unchanged. Other substances, likewise, which are not foods, but which we may eat or drink without any serious injury, instead of undergoing combustion, pass out of the body comparatively little changed. This character aids us in distinguishing between substances which are foods and those which are not. Water, which is by some reckoned as food, does not undergo combustion in the animal body, any more than it does in the steam-engine. Without it, neither the body nor the steam-engine could go on, but it does not supply the energy in either case, like the fuel in the furnace or the food in the body.

When we now come to ask whether alcohol is a food, we find that it agrees with sugar in many respects. It appears to undergo combustion in the body, for it is not excreted, excepting when taken in large quantities; and even sugar, when eaten in excess, is excreted as sugar, insufficient time having been allowed for its combustion: very much in the same way as if a stoker piled on coal so quickly that a good deal of it fell into the ash-pit before it could be consumed. A great deal has been made of the fact that when quantities of alcohol are taken some part is excreted unchanged as an objection to the claim of alcohol to rank as a food, but this objection, as we have just seen, is not valid. The chief claim of alcohol to the name of food, however, is that although, like sugar, it will not support life when given alone, it will help to do so if given along with other foods. Thus Hammond observed that when he put himself upon an insufficient diet he lost weight daily, but when he added to this diet a little alcohol, instead of losing, he began to gain weight. We find, too, especially in cases of disease, that people will often live a considerable time with hardly any other food than alcohol in one of its forms. We may consider, then, that alcohol is a food; but whether it is a convenient food or not is quite a different question. Sulphur burns easily, and might be used as fuel. Because it burns so easily it was formerly employed to tip sulphur matches, and there it was in its place; but it is also a popular remedy for chimneys on fire, because when thrown into the grate the sulphurous acid which it produces when burnt passes up the chimney, and puts out the blazing soot. It burns itself, but instead of aiding the combustion of the soot, it prevents it. So it is with alcohol. Alcohol undergoes combustion in the body, but at the same time it tends to lessen the combustion of other things. In healthy people this is, of course, a disadvantage, because it is by the combustion of our food that our strength is maintained. Alcohol is, therefore, for healthy people, a very inconvenient form of food. In fevers the case is different, because there the body is burning away too rapidly, and alcohol has the double advantage of retarding this process, as well as of acting itself as a food. In wines, beer, and spirits, alcohol is contained, but in each of them it is mixed with other things, which modify its action as a food. On comparing these substances, we see at once that the action of alcohol as a food and as a stimulant are not connected. If we take, for example, a quantity of beer and of brandy containing the same amount of alcohol, we will find that the beer is more nourishing, but the brandy is more stimulating. The stimulating power of alcohol, indeed, is considerably affected by its dilution. To a person who is fainting we would give brandy raw, and would not think of mixing it with a large quantity of water. Experience has shown, indeed, that a table-spoonful given pure would have far more effect than double the quantity in a tumblerful of water. This shows us that concentration modifies the effect of alcohol. In considering its action, we will have to distinguish between the effect it produces locally on those parts of the body with which it comes in contact, and its general action after it has been absorbed into the blood. We notice a very marked difference between the effect of brandy and brandy-and-water in the mouth. Pure brandy retained in the mouth for a short time—as, for instance, in relieving toothache—causes a sensation of burning, and when we look at the inside of the cheek, we see that it has become slightly whitened and corrugated. This feeling of burning and the whitening of the mucous membrane lining of the mouth are due to the effect of alcohol on the tissues. If we mix a little spirit of wine with white of egg (or albumen, as it is termed by chemists), we find that the albumen becomes more opaque and less fluid—that it is, in fact, coagulated. If we boil the white of egg it will also be coagulated by the heat. But we notice a difference between the coagulation produced by alcohol and by boiling. The coagulation produced by alcohol is less perfect, and if we add water to the coagulum, it will re-dissolve, whereas the albumen coagulated by heat remains unaffected by the water. The whiteness of the mucous membrane in the mouth after brandy has been held in it is due to the albuminous substances in the mucous membrane being partly coagulated by the alcohol; but the whiteness and burning soon pass away, for this coagulation is rapidly removed by the circulation. Boiling water would produce a similar whiteness in the mouth, but it would not pass away; and the intense burning pain would also be permanent, while the burning feeling caused by alcohol is very fleeting.

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* This is true only of the small quantities mentioned in a preceding sentence. In large quantities meat alone will support life, but it is not such convenient food as a mixed diet.

But before passing away from the mouth, we must notice that the brandy causes a profuse secretion of saliva. The saliva is secreted by a gland situated at a little distance from the mouth, and connected with the mouth by a narrow tube, or duct, through which the secretion flows. The orifice of this tube is very narrow, and opens in the form of a little papilla, which forms a kind of valve, so that while the saliva can readily pour into the mouth, fluids from the mouth cannot enter the duct. Consequently, the brandy cannot reach the gland, and yet, as the profuse flow of saliva shows, it affects it profoundly. It acts both on the mucous membrane and on the gland, but its action upon the two is of a different kind. It comes directly into contact with the mucous membrane, and thus affects it directly; it does not come into contact with the gland, and therefore can only affect it indirectly, by what is termed reflex action.

Reflex action plays a very important part in the body, and in order to understand the effect of alcohol, we must have a clear idea of what reflex action means. Here, also, a comparison may help us to form a more definite idea of the subject in hand. In some houses, where the outer gate or door is at some distance from the hall, the visitor pulls the door bell, but instead of the servant going to the door and opening it, he pulls a handle, which acts upon the distant door. In the case of reflex action, the servant is a nerve-centre, the door bell is a sensory, or afferent, nerve going to it, and the handle which the servant pulls to open the door is a motor, or efferent, nerve passing from the nerve-centre to the part of the body which is to be set in action. The part corresponding to the door may be either a muscle or a gland. To apply this to the saliva, we may say that the brandy is the visitor, the door bell which he pulls is the sensory nerves of the mouth, the servant is a part of the brain, and the handle which he pulls is a nerve which goes to the salivary gland. When everything is quiet, no secretion takes place; but when a stimulus is applied to the end of the sensory nerves by the brandy taken into the mouth, it is passed up the sensory nerves to the nerve-centre, thence down the efferent nerves to the gland; the gland begins to secrete, and the saliva flows freely. It is evident that a reflex action of this sort may be stopped in several ways. If the door bell be broken, the servant will not be warned of the visitor's presence; if the servant be asleep, he will pay no attention to the warning given by the bell; if the handle be broken, the door will not open, however much he may pull at it; and if the servant has been rung up a number of times violently, he may by-and-bye get tired, and will not answer to a gentle pull. Something like this we find in the case of alcohol also, for the morning after too great an indulgence in spirits the mouth is very apt to be dry. It is perhaps hard to say what part is here in fault, but most probably it is the nerve-centre, which has been partly stupefied by the alcohol, and no longer responds to the ordinary slight stimulus given by the motions of the tongue and lips.

When we follow alcohol from the mouth to the stomach, we find that there too it produces a sensation of warmth. If taken in very large quantities, it would, no doubt, produce the same whitening and burning that one notices in the mouth, but the stomach being so much larger than the mouth, a very large quantity would be required to produce this effect—a quantity so large as probably to kill the person at once—for reflex action occurs from the stomach as well as from the mouth; and one of the organs which is very closely connected with the stomach in this way is the heart. A blow on the stomach will sometimes cause instantaneous death, and a very large quantity of spirits taken at a draught has a somewhat similar effect, producing reflexly great depression, or perhaps even stoppage of the heart's beats. In this case, the impression made by the brandy is transmitted by the sensory nerves of the stomach up to a nerve-centre, known as the medulla oblongata, at the upper end of the spinal cord, and thence down by the so-called inhibitory, or restraining, nerves to the heart.

When taken in smaller quantities, however, the effect of brandy is quite different. The impression it makes on the stomach is transmitted to the medulla oblongata by the sensory nerves, but instead of being sent down the inhibitory nerves, it is transmitted by the stimulating nerves of the heart, and thus increases the rapidity and strength of its pulsations. Closely associated, in the medulla oblongata, with the nerve-centre governing the heart, is one which regulates the size of the vessels. This is also affected reflexly by alcohol. The consequence of this is that the vessels in the stomach itself dilate; its mucous membrane becomes rosy-red, and secretes freely; the vessels throughout the body also dilate; the skin is covered with a rosy blush; a free supply of blood is sent to the brain; thought becomes more ready, and bodily exertion more easy. The increased supply of blood to the stomach, to the skin, and to the nervous system, have beneficial effects on these parts, which we shall presently consider more in detail.

But it must be remembered that the effects just mentioned are reflex—that is, are due to the local action of the alcohol on the stomach, before any of this has been absorbed; and we shall afterwards have to consider the way in which these are modified by the effect of the alcohol on the different parts of the body, after it has been absorbed and carried to them by the blood. Effects very much like these may be produced by a draught of any warm liquid which is pleasant to the taste, although it contains no alcohol, and will even be produced to a considerable extent by hot savoury food. They come on so shortly after the introduction of the alcohol, or of the food, or of the warm drink into the stomach, that we can hardly suppose that there has been time for absorption; and besides, we find that, although all these three things produce similar effects at first, their action is considerably modified after time has been allowed for their absorption, and conveyance by the blood to the various parts of the body.

Let us now examine the effect of alcohol on the stomach itself in moderate quantities. Although an instrument has been recently devised by which the interior of the stomach can be seen, it is still extremely difficult to use, and previous to its invention it was impossible to see what was going on in the interior of the stomach, except under exceptional circumstances. A number of years ago, however, a Canadian hunter, named Alexis St. Martin, met with an accident by a charge of shot entering his side and penetrating his stomach; the wound healed, but the stomach was adherent to the side, and an opening remained through which one could look in, and see what was going on in it. A similar condition was afterwards established in dogs by Bernard and Blondlot, and by means of observations made in this way the effect of various conditions on the stomach has been ascertained. On looking into the empty stomach, the mucous membrane which lines it is seen to be moderately pale and dry. It has a somewhat velvety look, and under the microscope the velvety pile is seen to consist of numerous minute tubes, standing close to each other, and filled with cells, which secrete the gastric juice. It is to this juice that the digestive power of the stomach is due. It does not dissolve all kinds of food, but only proteids, the starches and fats being dissolved by the secretions from the other parts of the intestinal canal. When the mucous membrane of the stomach is slightly stimulated by touching it with a feather or a glass rod, or by the introduction of food, its vessels dilate, its colour at once becomes of a rosy-red, and the gastric juice which is to dissolve the food is rapidly secreted, and stands in beads on the surface. These soon coalesce, and run in little streams along the membrane.

This is the effect of a slight stimulus on a healthy stomach, but when the stimulus is too powerful the result is quite different. If the rod be rubbed too hard over the interior of the stomach, the vessels which had become dilated by the gentle stroking contract, the mucous membrane becomes pale, the secretion of gastric juice is arrested, and a ropy mucus is secreted instead; if the irritation be pushed still further, signs of nausea appear, and vomiting may occur.

These are the effects of over-irritation on the stomach previously healthy; but in order to understand thoroughly the effect of alcohol, we must consider that the stomachs of those who take it are not always healthy. The persons may be weak and debilitated; then their stomachs will share in the feebleness of the body generally. In those stomachs which are below par, a stronger stimulus than usual may be necessary to produce a healthy secretion. In others the stomach may be already irritable, and the stimulus which in a healthy stomach would be only sufficient to cause a proper secretion of gastric juice may produce on the irritated mucous membrane the same effects as an over-stimulus on a healthy one, leading to a secretion of mucus, nausea, or vomiting. The secretion of gastric juice by the walls of the stomach is only the first part of the process of digestion in it. In the mouth the food is broken down by mastication, and is mixed with saliva; this both renders it more easy to swallow, and partly changes the starch into sugar. This is readily observed by simply chewing a piece of dry bread for a little while, when it will be found to acquire quite a sweet taste. When the food is swallowed and reaches the stomach, it acts as a gentle stimulus to the gastric mucous membrane, and causes a secretion of gastric juice in the way just described. This juice dissolves the albuminous matters, such as meat, fish, eggs, cheese, and the albuminous constituents of milk; and it renders more soluble the gelatinous substances contained in sinew. It does not dissolve the starchy parts of our food, but the digestion of these continues to be carried on in the stomach by the saliva swallowed with them. The solvent principle of the gastric juice is pepsine, a substance which is insoluble in alcohol, and can be precipitated from gastric juice by mixing it with alcohol. It only acts in solution; and gastric juice mixed with much alcohol has no digestive power. Even when the quantity of alcohol is insufficient to precipitate the pepsine, it seriously impairs its digestive properties. We can readily see, then, that a large quantity of alcohol will be very detrimental indeed to digestion, although a small quantity may be innocuous, or even beneficial. When the quantity is small, so as not to over-excite the stomach, it will induce healthy secretion of gastric juice, and will also stimulate the movements of the stomach, which tend to mix up the food with the gastric juice, and thus aid digestion. Its effect upon the movements of the stomach is not unfrequently evidenced by its tendency to cause the expulsion of any gas which may be present in the stomach when it is taken.

In persons below par, the addition of a little alcohol to the food may be of advantage; and Paul showed his wisdom in recommending Timothy to take no longer water, but a little wine "for his stomach's sake, and his often infirmities." A condition of this sort is sometimes met with in persons who are otherwise perfectly healthy, but who are depressed by town life and hard work. During their holiday they feel perfectly strong, and have no need of alcohol; but when they return to hard work in town, they find their strength flagging, although they do not notice any derangement of their digestion. Their appetite may be smaller, but such food as they take appears to be perfectly well assimilated; they do not appear to suffer from dyspepsia, and the diminution of strength is the only thing they notice. Sometimes, in consequence of this, they go on trying the experiment of living without alcoholic stimulants for months together, but are forced by increased weakness to have recourse to them again. They then find that a very small quantity of wine or beer taken with their food is sufficient to bring them up to par, and enable them to go comfortably on with their work. In one case described to me by Dr. Mitchell Bruce, a gentleman found that he invariably suffered from diarrhœa unless he took some alcohol with his food. A little brandy-and-water, however, taken with his meals invariably stopped it. In all probability, the explanation of this occurrence is that food alone did not sufficiently stimulate the secretion of gastric juice; digestion in the stomach was therefore slowly carried on, and either the undigested food itself, or the products of its decomposition passing out from the stomach into the intestine, caused irritation and diarrhœa. The alcohol, stimulating the secretion of gastric juice, quickened digestion, and thus restored the healthy condition. In the old and feeble, alcohol taken with meals may in moderation be very useful, and may sometimes be so also in men otherwise healthy and strong, but who are exhausted by over-work and fatigue.

But in excess alcohol is doubly injurious at meal-times. By causing over-irritation of the mucous membrane it diminishes the secretion of healthy gastric juice, and causes the secretion of mucus, which, instead of aiding, interferes with digestion. Besides this, the alcohol itself interferes with the action of the gastric juice. So much, indeed, is digestion retarded that I remember on one occasion seeing a man suffering from *delirium tremens* vomit undigested matters which he told me were the remnants of a dinner he had had four days previously.

We will now pass on to consider the effect of alcohol upon the circulation and nervous system. We have already mentioned that a quantity of strong alcohol swallowed at once will depress the heart, and produce shock or collapse, in much the same way as a violent blow in the epigastrium. Small quantities, on the other hand, stimulate the heart, increase the circulation, give a sensation of comfort and strength, and may enable the person, for the time being, to do more work, bodily or mental; but these effects are modified by the action of the alcohol after it has been absorbed. It has already been said that all the powers of the body are maintained by processes of combustion. Long ago it was supposed by some that the stomach was the furnace of the body; others, again, supposed it to be the liver; others, again, the lungs. Now we know that combustion takes place in all parts of the body. This combustion cannot occur without the presence of oxygen, and the oxygen of the air cannot reach the remote parts of the body directly. It is, however, carried to them by the blood, which takes up oxygen in the lungs, and, carrying it to the various parts of the body, gives it off readily to the tissues. Binz, Schmiedeberg and others have shown that one of the effects of alcohol is to lessen this oxygen-carrying power of the blood, and thus to interfere with the combustion which takes place in the various parts of the healthy body, and is so necessary to the maintenance of their functions. When the quantity of alcohol is small, this effect will be but slight, and may be much more than compensated by the increased circulation of blood which alcohol causes; but when the proportion of alcohol in the blood comes to be considerable, the importance of this action is greatly increased, and it may cause very marked results indeed: *e.g.*, when alcohol is taken frequently for a length of time, as in chronic drunkards. In these persons the impaired combustion may lead to the accumulation of fat, resulting in obesity, or to the partial conversion of other tissues of the body, such as the muscles, into fat. This produces weakness, and as the heart becomes affected in common with other muscles, the circulation fails and life is shortened. As the alcohol flows with the blood from the vessels and is carried by them to the nerve centres which govern them, the vessels on the surface of the body dilate, and the warm blood rushes freely through, producing a comfortable glow. This effect may be often observed very plainly by looking at the hands before and after alcohol has been taken. The skin which was at first pale, mottled, or even bluish from cold, becomes, as the vessels dilate, of a clear rosy red. This colour is uniformly distributed, showing that all the minute capillary vessels have become enlarged; and the veins which were before small, dark, and contracted, become full, large, and pale blue, showing that the blood is now circulating freely through them, and instead of being very dark has become much lighter in colour, or, in other words, more arterial. The warm blood coursing freely through the skin gives a sensation of warmth, for it is through the skin that we are conscious of heat or cold, and the temperature in other parts of the body may be very high, and yet we are unconscious of it if the skin is cold. Thus it has been found that the temperature of the interior of the body has been very many degrees above the normal in cases of cholera where the patient was apparently icy cold, and if we put a thermometer in the mouth of a person suffering from an ague fit, we will find it indicate fever-heat, although the patient is shivering from cold and crouching over the fire in the vain effort to warm himself. The cutaneous vessels of the skin having contracted, they prevent the hot blood from the interior of his body from circulating through the skin, and so we see him pinched, pale, and shivering. But so soon as this spasm relaxes and the fevered blood again circulates through the skin its high temperature is at once perceived by the cutaneous nerves, and the patient passes suddenly from a feeling of excessive cold to one of excessive heat. Now, the power of the vessels of the skin to contract is one of very great importance in regard to the regulation of the animal heat. In so-called cold-blooded animals, such as fish, amphibia, and reptiles, the temperature of the body varies with that of the surrounding medium, air or water, in which the creature lives. But in warm-blooded animals—birds and mammals—the temperature of the body remains nearly constant, whether that of the external medium be high or low. The range of temperature in which the vital functions can be carried on in warm-blooded animals is very limited; at a few degrees below the normal they completely cease, and a rise of a few degrees above will cause their permanent arrest and the speedy death of the animal. Heat is constantly generated in the body by the combustion going on in it, but its amount would be too small to maintain the proper temperature in cold countries unless there were some mechanism in the body to prevent its being readily given off from the surface. In hot countries, where the external temperature is higher than that of the body, an arrangement is requisite, on the contrary, to lessen the heat of the body. The skin is the apparatus through which the regulation is produced in both instances. When the air is cold, the vessels of the skin contract and prevent the blood from circulating readily through it. The skin from which the blood is driven by the contraction of the vessels becomes pale and cold. When the contraction is so great as to stop the flow of blood through them entirely, a bluish colour is perceived, because the blood in the vessels has become so venous as to acquire a black colour, which, showing through the skin, gives to it a bluish or livid appearance. The skin and cellular tissue below it are bad conductors of heat; and the rest of the body is thus protected from cooling by the skin and subcutaneous tissue, in much the same way as a teapot is prevented from cooling by a cosy. The blood which circulates in these protected parts retains its high temperature, and thus the vital processes are not interfered with. In warm-blooded animals, such as porpoises or whales, the skin and cellular tissue alone would be insufficient to protect the vital organs from the external cold, for this in the case of whales in the Arctic Ocean is sometimes most intense. But in them the protective power of the skin and subcutaneous tissue is greatly increased by the deposit in the cellular tissue of an enormous layer of fat, which is a very bad conductor. Were it not for this, the cold, passing through the skin, would quickly chill the muscles, so that they would no longer respond to the impulses of the will. This effect was seen in the champion swimmer Johnson, who attempted to cross the Channel, but who had to be lifted into the boat perfectly powerless and unable to raise a limb before he had advanced many miles. The same thing would almost certainly have happened to Capt. Webb had he not, in addition to the oil which he rubbed on his skin externally, possessed a fair amount of subcutaneous fat, which protected his muscles from the chilling effect of the external cold.

So long as the vessels of the skin, subcutaneous tissue and its fat, are contracted, the loss of heat from the surface of the body is to a great extent prevented. But when the cutaneous vessels dilate, the warm blood from the interior rushes freely through them, the skin itself becomes very warm, and if the external air be cold this warmth is rapidly abstracted. When the air is very dry its conducting power is small, and so it does not chill the skin much, excepting when in motion. Consequently the skin can be exposed to air 50° below zero without a feeling of great discomfort if the air be perfectly still; but if the air be in motion, heat is rapidly abstracted at this low temperature. If the air be moist it conducts away heat much more rapidly, and excessive cold may be felt when the thermometer indicates only a few degrees below the freezing-point.

When the air is hot the vessels of the skin dilate and the blood flows freely through them. If the external temperature be higher than that of the body, as it is in the Tropics, this arrangement would tend, instead of lowering, to raise the animal heat, and thus to cause death; but this effect is prevented by the occurrence of sweating. Under the influence of heat the sweat glands pour forth an abundant secretion by which the skin is kept constantly moist, and abundant evaporation takes place. Now, the quantity of heat required to produce evaporation is very great, the heat being converted in the process into the mechanical work of changing the water from a liquid into a gaseous form. It takes five and a half times as much heat to convert boiling water into steam as it does to raise the water from the temperature of freezing to that of boiling. The immense loss of heat by the evaporation of perspiration thus keeps the bodily temperature normal, even when the external heat is excessive. In negroes the evaporation cools down the skin so much that it has been observed on the West Coast of Africa that when in health their skin is as cold as marble while streaming with perspiration, and that heat of the skin is in them always a sign of fever.* Sir Charles Blagden† also found that in a room the air of which had a temperature of 198° Fahr., his side felt cold like a corpse to the touch.

The skin is thus one of the great regulators of temperature. To recapitulate shortly: external cold makes its vessels contract, and confines the warm blood to the interior of the body; external heat makes its vessels dilate and the sweat glands act, and thus the body is cooled by evaporation. The sensation of heat and cold is chiefly perceived in the skin, and our subjective sensations are regulated by its temperature rather than by those of other organs. We may now understand how it is that in cold climates men take alcohol to make them warm, and in hot climates to cool them. The effect of alcohol is to cause dilatation of the vessels of the skin, and thus to allow the warm blood from the interior of the body to circulate freely over the surface. The consequence of this is a pleasant glow of warmth. This dilatation, of course, allows opportunity for more rapid loss of heat, but if the external temperature is not very low this loss may be of no very great importance, and the individual may enjoy a temporary pleasure without any bad effects. But in extreme cold, as for example in the Arctic regions, or even in this country if the exposure is to be prolonged, the case will be very different. Sir Joseph Fayrer tells me that on one occasion while deer stalking he offered the keeper some spirits from his flask, but his offer was refused on the ground that the day was too cold. Previous experience had shown the keeper that although the temporary effect might be pleasant, the after effects during prolonged exposure were disagreeable.

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* S. Billing: "Journal of Science," October, 1882, p. 620.

† Brewster's "Letters on Natural Magic."

The experience of the lumberers in the forests of Canada has taught them the same thing. During the intense cold of a Canadian winter these men are engaged in felling trees, which are afterwards dragged over the snow to the nearest river. They are then made into rafts and floated down the current to the large towns in the ensuing spring. These men are fond of spirits, and when they reach the towns in spring generally give way to intoxication; but during the winter they are strict abstainers. They know the danger of indulgence, and knowing also the strength of temptation, they refuse to have spirits in the camp; and if a keg of whisky happens to find its way there they will deliberately destroy it, lest they should be led, in spite of their resolution, to indulge in the luxury to their own injury. Dr. Milner Fothergill tells me that a party of Americans crossing the Sierra Nevada encamped in an exposed place above the snow-line before going to sleep. At night some of them took no spirits at all, and they lay down cold and miserable; some of them took a moderate quantity, which slightly warmed and cheered them for the time; some of them took a quantity, and they lay down feeling very warm. But next morning those who had taken no spirits got up quite well, those who had taken a little rose cold and wretched, while those who had taken a quantity slept the sleep of death. In those who had not interfered with the healthy regulation of their temperature by taking alcohol the skin was chilled, but the temperature of the heart and vital organs was maintained, and beyond temporary discomfort they received no harm from the exposure. Those who took a small quantity of spirits, and thus dilated their cutaneous vessels in spite of the external cold, warmed their skin and felt comfortable; but it was at the expense of the general body-heat, and so they paid by subsequent discomfort for their temporary pleasure. Those who had taken a large quantity continued to warm the surface for some hours at the expense of their vital organs. At each round the blood returned to the heart colder and colder, until the pulses ceased and the unfortunate people were frozen to death. The experience of all Arctic travellers tells the same story—that indulgence in alcohol is almost certain death when the external cold is great.

Under certain circumstances, however, alcohol is useful in counteracting the effects of exposure. The expulsion of the blood from the vessels of the skin by exposure to cold increases the quantity in the interior of the body, and may occasonally tend to produce congestion, or lead to inflammation of internal organs. For example: a lady was travelling in Scotland one cold day on the outside of a coach, and, as the surface became colder and colder from exposure, she began to suffer internal pain. Her husband wisely gave her a glass of brandy, which at once removed the pain. Here the danger was from internal congestion, and this had to be balanced against the effect of exposure. But although from the atmospheric conditions which have already been alluded to the subjective feeling of cold was considerable, the external temperature was not extremely low, and the surface was protected by warm clothing; the chief danger here lay not in too rapid a loss of heat from the surface, but from the occurrence of internal congestion, and therefore, as the successful result proved, the use of alcohol was right and proper. Also, after the exposure to cold is over, the cutaneous vessels are sometimes long in relaxing, even after the person has come into a warm room. The consequence of this is that the external warmth has little effect upon the general temperature of the body, or even upon the deeper layers of the skin, and thus the person cowers, cold and shivering, over the fire, or turns round and round in front of it, in the vain attempt to warm himself. If a glass of spirits be now swallowed, and especially if it be mixed with hot water, it rapidly causes the vessels of the skin to dilate, the blood circulating over the surface is warmed by the external heat, it returns warm from the skin to the heart, and soon a comfortable glow succeeds the previous chill. Not only is comfort thus afforded, but the distribution of the blood being once more equalised between the surface and the interior, the danger of internal congestion is diminished. In many cases simple hot water and sugar, flavoured with a little ginger or lemon, a cup of warm milk or tea, or of coffee, is sufficient to produce a similar effect; but their action is not quite so strong as that of hot water and spirits, inasmuch as the alcohol has a special power of dilating cutaneous vessels apart from the hot water with which it may be mixed. While, therefore, the other warm drinks are useful in slighter cases of chill, spirits and water are more likely to be efficacious when the chill is severe.

In hot climates the effect of spirits is to dilate the cutaneous vessels in the way just mentioned, and the flow of blood to the surface being accompanied by increased secretion of the sweat glands, the loss of heat by evaporation is augmented, and thus the person feels cooler instead of hotter.

We must now consider the effect of alcohol on other parts of the nervous system than those which regulate the vessels. One of the first effects is, as we have said, dilatation of the vessels and acceleration of the circulation. The increased supply of blood to the brain and spinal cord may augment their functional activity, rendering thought more easy and action more ready, without any alteration in the character or precision of either. But when the quantity of alcohol is larger the nerve centres of thought and action are themselves affected by it. It is possible that the function of the various parts of the brain is somewhat increased by the direct action of the alcohol upon them when it is carried to them by the blood, and that this increase is apart from the greater supply of blood which they obtain from the freer circulation; but such an increase, if it exists at all, is in all probability both slight and temporary, and is succeeded by weakened power, and finally by paralysis. To the increased mental and physical power, due to the quickened circulation, succeeds a stage which one might at first sight believe to be one of increased power, but which a more careful examination will show to be one of diminished mental power. To the stimulant action succeeds the narcotic, although it is difficult to draw an exact line of demarcation between the two. The action of a narcotic is to lessen the closeness of the relationship between the organism and its environment, and the delicacy of its power of adjustment to external circumstances. In consequence of this we see the restraints which the individual usually puts upon himself, out of consideration for his surroundings, gradually disappear, and the faculties of his mind thus let loose are like a fly-wheel from which a break has been removed. The individual figures more largely to himself; he becomes more, and his surroundings become less important to him. His tongue runs more freely, his imagination becomes more lively, and ideas seem to succeed one another with increased rapidity. His emotions become more easily excited, and manifest themselves more plainly than usual, as sympathy, affection, or pugnacity. All those appearances of increased mental power may be explained, and probably correctly, on the supposition that the highest faculty of all—viz., the power of self-restraint—is weakened by alcohol.

The old proverb, *in vino veritas*, shows that under the influence of wine men forget their caution, and their power of self-restraint being impaired, they let out the secrets which they ought carefully to have preserved. From one faculty to another the paralysis gradually proceeds, and the order in which this takes place, although it varies to a certain extent with the individual, and also with the variety of alcoholic drink employed, may generally be said to be in the inverse order of their development. The new-born infant has but few of the powers possessed in manhood ; its heart beats and its lungs breathe, and it can make irregular movements ; but it has no power of receiving exact impressions, or of using its limbs for definite intended acts. The more complicated the actions which the different parts of the body have to perform the longer are they in being acquired, and the child is first able to move its body, which in adult life performs no complicated actions; afterwards its arms; and lastly the fingers, which finally acquire great delicacy and precision of movement. This is well expressed by Tennyson in the "Princess," where he describes the movements of a child lying on the ground and seeing its mother approach. Moved with delight it began

> "A blind and babbling laughter, and to dance
> Its body, and reach its fatling innocent arms
> And lazy lingering fingers."

Its excitement, as Herbert Spencer puts it, flooded along the nerve channels which afforded the easiest passage, and while at that early age the nerves connected with the body were already complete, the nerve centres for the fingers were still undeveloped. In some people, even up to old age the nerve centres go on growing, for some persons are able even in old age not only to acquire new ideas, but new expressions, new languages, and even new and unaccustomed movements of the fingers. Now, these acquirements are the external indications of alterations and of new development going on in the nerve centres. It is only in very exceptional instances that we find this power retained in old age; in most people it is very much diminished after middle age, and is most active in childhood and youth. We see that it is usually very difficult for any one to acquire in later life the complex movements of those fingers, for example, which are required to play the violin, the nerve centres being then little capable of undergoing the necessary modifications which would have occurred comparatively easily in youth. It is not only the nerve centres which are most readily modified in early age, the whole being is more easily acted on by external influences until after a certain time, when the face and figure acquire a definite character, or become, as it is usually termed, "set." In watching the development of faculties in children, we see that one of the first powers acquired is that of laughter. They learn to understand the meaning of words before they can speak. Some children learn to speak before they can walk ;

others, again, walk before they can speak. But in all of them the powers of wise consideration and of self-restraint are of late development, and these, as we have seen, are among the first to be affected by alcohol, which thus tends to reduce the adult more and more to the state of a child. The nervous channels which have been, so to speak, graven by education become one by one obliterated in the order of their development, and the nervous energy, which ought to have been distributed over them all, runs only through the older and simpler channels. Self-restraint and consideration being lessened or destroyed, fancy is set free and expression is unchecked, so that we see in adults under the influence of alcohol the same fertile imagination and easy chatter that we get in the child. We notice also the same tendency to ready excitement and display of the emotions: to laugh, to cry, to sing, to fight. In some children the power of speech is long in being acquired, and they are unable to express their ideas and feelings in words, although it is quite evident from their actions that their mental faculties are in no way deficient. Others, again, acquire the power of speech very soon. Just as we find differences in the readiness with which speech is acquired, so we find differences in the rapidity with which it is lost under the action of alcohol. In some people the power of expression is diminished before the mental faculties are much affected, and the earliest indication that they have taken more acohol than is good for them is afforded by the difficulty of articulation. In others, again, this difficulty does not set in until the ideas are so confused as to be unworthy of expression.

In children we notice differences in the comparative readiness with which the powers of walking and of speech are acquired, and this also can be observed under the action of alcohol. Some people appear perfectly sober as long as they are sitting, but when they arise they are unable to walk steadily. Others, again, are able to walk perfectly well when they are so stupid as not to know what they are about.

This is usually expressed by saying that "one man gets drunk in his head, and another in his legs." This phrase expresses the condition distinctly enough, but it is not quite correct, inasmuch as the two greatest nerve centres which alcohol affects are both situated in the head—viz., the cerebrum, which is the organ of thought, and the cerebellum, the nerve centre which co-ordinates the movements of the different muscles, or, in other words, makes them act harmoniously together so as to produce the movements required to maintain the balance of the body, either in standing or walking.

The loss of co-ordination which first affects the muscles of the tongue or of the legs extends from them to others. Those of the eye no longer act together, and so double vision is produced. Indeed, the staggering of a drunken man is probably due for the most part to erroneous conceptions of the position of surrounding objects. He generally seems to have the idea that he himself is perfectly steady, and that all his troubles are due to the movement of the ground on which he is standing, or the houses, trees, railings, and lamp-post near which he happens to be. But even after the power of co-ordinate voluntary movement is gone, we find that reflex action will still continue in the spinal cord, and it appears to be in consequence of this that a man is able to ride when he cannot walk. When something is put into one's hands the fingers have a tendency to close upon it unconsciously, the impression made upon the skin passing up the sensory nerves to the spinal cord and down again through the motor nerves to the muscles, while the brain has little, if anything, to do with it. So when a drunken man is put upon a horse, the impression made upon the skin of his thighs by the pressure against the saddle is transmitted up to the spinal cord, and reflexly down the motor nerves to the muscles of the legs. This motor impulse causes the muscles to contract so as to retain him in his seat, although the upper part of his body may be swaying helplessly about. It has been noticed that drunkards in this condition enjoy a remarkable immunity from the consequences of injuries. One sometimes sees a drunken man pitched violently from a horse, and when the bystanders rush to the spot, expecting to find him dead, they are astonished to discover that he has been little injured. In his "Scrambles among the High Alps," Leslie Stephen tells the story of a guide who, while drunk, fell over a precipice so deep that a fall over it seemed almost certain death, and who yet sustained little injury. Stephen accordingly gives his readers the advice either not to fall over a precipice or to get thoroughly drunk before doing so. I myself once saw a man who had thrown himself while drunk over the Dean Bridge in Edinburgh, a height of about 200 feet, on to the rocky bed of the stream below. A sober man would probably have been instantly killed, but this individual, though he had broken both of his thigh bones, quickly recovered; and I saw him a few weeks afterwards hopping briskly about on crutches, the legs being nearly, though not entirely well.

The reason of this immunity probably is that the nerve centres which regulate the heart and vessels are so much paralysed in the drunken man as not to be affected by the shock of the fall, which in a sober man would have acted on them so violently as to stop the heart, arrest the circulation, and cause instant death.

The alcohol which is circulating in the blood in this condition is partially burnt off, but a good deal of it is removed from the body by the kidneys, although little or none is excreted by them when small quantities only of alcohol have been taken. When the excess has not been too great the patient gradually recovers his powers as the alcohol is eliminated, and fortunately in man we do not often meet with cases of absolute poisoning by a single indulgence in alcoholic liquors. By giving it to animals we are able to see its further effect, and we find that in them the nerves which keep up the respiratory movement become paralysed, the heart itself becomes feebler and feebler, both respiration and circulation stops, and the animal dies. We see, then, that with the exception of the primary stimulation caused by its effect on the circulation—and possibly to a very slight extent indeed, if at all, on the nerve centres themselves—the action of alcohol is one of progressive paralysis, affecting the highest powers of the mind first, and reducing the man first to the condition of a child, and afterwards not only to, but even below that of a beast. Even if it should not actually poison the individual and kill him at the time, the consequences which ensue from excess are by no means agreeable; the individual gradually recovers his powers as the alcohol is eliminated, but he does not, as a rule, recover his health and comfort at once; his salivary glands do not secrete, his mouth is dry and his tongue foul, while his stomach is even more deeply affected. This was well seen by Dr. Beaumont in the case of Alexis St. Martin, the Canadian huntsman, to whom reference has already been made. The inner coat of the stomach, which in its natural and healthy state was of a light or pale pink colour, and of a soft, velvet-like appearance, on the day after intoxication was of a darker red than natural, dry, irritable, and its mucous coat abraded in spots. This condition is usually accompanied with loss of appetite and thirst, and the disordered condition of the nerve centres leaves behind an intense headache, which should act as a warning against a repetition of the indulgence. If this warning is not taken, and spirits are drunk again and again, we find that the symptoms of apparent disturbance pass away; the person may feel quite well, the nausea is gone, thirst may be absent and the appetite may be good; to all external appearance the continued use of spirits has done away with the evil effects of the primary indulgence; but this is not the case. Dr. Beaumont mentions that after St. Martin had been drinking spirits pretty freely for eight or ten days he complained of no pain, showed no symptoms of general indisposition, said that he felt well and had a good appetite; but on looking into the stomach the condition was very far from being healthy; its mucous membrane was morbidly red and congested; there were small white patches of aphthæ on the surface, and the secretions were vitiated; the surface was tender, and blood seemed to exude from the congested parts. Even when the stomach became still worse, with more extensive congestion, and livid spots on the surface, from which small drops of grumous blood exuded, larger and more numerous aphthous patches, and the gastric juice so mixed with thick ropy mucous and ropy purulent matter slightly tinged with blood as to resemble the discharge from the bowels in chronic dysentery, St. Martin complained of hardly any symptoms; all that was noticeable was a slight uneasiness and tenderness at the pit of the stomach; some giddiness, dimness, and yellowness of vision on stooping and rising; a thin, yellowish-brown coat on the tongue, and rather a sallow appearance of the countenance; his pulse remained uniform; he rested normally, slept well, and had a good appetite. A large quantity of alcohol, as we have seen, prevented the body from being affected by shock, and continuous indulgence seems also to rob the body of the power of perceiving the injury which the alcohol is inflicting upon the stomach and other parts of the organism. The warnings of danger which pain ought to give are no longer perceived, and the individual pursues his deluded course in fancied safety. This condition is well described in Proverbs, where the writer warns those who indulge in wine in the following words: "Yea, thou shalt be as he that lieth down in the midst of the sea, or as he that lieth upon the top of a mast. They have stricken me, shalt thou say, and I was not sick; they have beaten me, and I felt it not. When shall I awake? I will seek it yet again."* Unconscious, then, of his danger, a man may go on indulging in great excess; but if this is carried on continually beyond a certain point, the usual consequences are that the appetite fails, food is refused, the nutrition of the nervous system suffers and delirium tremens results. When in charge of a hospital ward intended for the reception of such cases, I found the usual history to be that four days before the outbreak of the attack the appetite failed, and either food was not taken at all or was at once rejected. Obstinate vomiting is frequently a marked symptom in this disease, forming an obstacle to the patient's recovery, and sometimes leading to exhaustion and death. The muscles become tremulous, this tremor being readily remarked in the tongue when it is protruded. The patient is restless and sleeps badly, and is disturbed by unpleasant dreams; then in place of dreams occurring only during sleep, he becomes plagued by hallucinations when awake. At first these occur especially at night, but afterwards continue during the day; they are nearly always of a disagreeable kind, and are sometimes perfectly fearful. They not unfrequently take the form of insects or animals, which are crawling around or over him; or he sees strange persons or devils, who haunt the room, hiding in corners, concealing themselves behind the curtains of his bed, or gibbering and mocking him, pulling at him, or tormenting him. He lives in a state of terror, and requires to be carefully watched lest in his attempts to escape from some fancied tormentor—man, animal, or devil—he should destroy himself by throwing himself out of the window if confined to his room, or over a bridge if he should be walking outside. This condition, after lasting for three or four days, passes off, the patient falling asleep and awaking convalescent. But sometimes, especially in those who have already suffered from repeated attacks, a fatal result ensues, the individual falling into a condition of stupor from which he cannot be awakened, and which gradually increases until death ensues. In other cases the patient becomes worn-out and death ensues from weakness; sometimes, also, the patients die suddenly without any apparent cause.

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* Proverbs xxiii. 34, 35.

When excessive indulgence in alcohol is frequently repeated, death may ensue from delirium tremens as just described; but even when the excess is not so great as to lead to this result, the organisation becomes gradually deteriorated. This deterioration may occur in men who have never shown symptoms of intoxication—who have drunk much, but may never have been drunk in their lives. The organs chiefly affected are the nervous system, the stomach, the liver, and the kidneys; other parts of the body, however, are not exempt, and the countenance and complexion very often betray the alcoholic habit. The impairment of combustion which alcohol produces in the tissues leads to the accumulation of fat, and even to the conversion of the muscular tissues into fat; the skin acquires a satiny feeling; the capillaries of the face, and especially of the nose, become permanently dilated, giving to it a rubicund appearance; the features lose their sharpness of outline, and the aspect becomes bloated. The stomach suffers in the way which has already been mentioned: a state of chronic inflammation is induced, the tongue becomes furred, the breath offensive, the appetite is lost, and there is vomiting—especially in the mornings. Inability to eat breakfast, nausea, and vomiting after rising in the morning, are often indicative of alcoholism, although they may proceed from other diseases quite unconnected with it. Just as we saw that individuality altered the order in which alcohol affected the different parts of the nervous system during the process of intoxication, so we find that the order in which different parts of the body suffer in chronic alcoholism varies with the individual; in some the stomach suffers, in others the liver, in others the kidney, and in others, again, the nervous system is most easily and seriously affected. Everything that is taken into the stomach and absorbed from it by the blood must needs pass through the liver before it can get into the general blood stream by which it is to reach the brain and kidneys. We naturally expect that the liver would be likely to suffer from any irritant taken into the stomach and readily absorbed like alcohol, and this is the case. From the effect of the alcohol the liver is apt to become larger and its structure loaded with fat, while the connective tissue which holds together the secreting cells which compose the main part of its bulk also increases. By-and-bye, the fat becomes absorbed, the connective tissue encroaches more and more on the secreting structure and also on the blood-vessels, the liver becomes small and hard, the flow of blood throughout from the stomach and intestines is impeded, fluid consequently accumulates in the abdominal cavity, and dropsy is the result. Sometimes this occurs in men whose nervous system, stomach, and kidneys appear to have suffered but little; their faculties remaining unimpaired, their appetite being good—or at least fair; and the dropsy being limited to the abdomen. In others, again, the kidneys suffer more, and then the dropsy extends to the whole body, and not unfrequently the patient dies from stupor or convulsions, due to the accumulation within the body of the waste products which his diseased kidneys are unable to eliminate. In others, again, the nervous system suffers most: the will may be impaired, and the individual become vacillating; the moral sense is diminished, and the distinction between right and wrong, between truth and falsehood, is less clearly perceived; the power of self-restraint gradually disappears, and although the individual may show great compunction for his failings, he is unable to resist temptation, and yields to it as often as it presents itself. He may appear to cherish kindly and loving feelings towards his family and neighbours, but these are chiefly subjective, and do not lead to definite action; for although he may see that he is causing them the most intense miseries by his conduct, he continues his course, while he may at the same time loudly bewail its consequences; again and again he may take the pledge, and again and again he breaks it; his will has been destroyed by the poison, and he is now helpless to resist. The recoveries from a condition of confirmed drunkenness are few, but they do occur. One case—which the unfortunate sufferer has himself described—was that of the Rev. J. Vine Hall, better known as the author of a little book called "The Sinner's Friend." His description of his condition and cure will well repay perusal.

The Causes of Intemperance.

The causes which lead to intemperance are various, although, as we have said, the reason why men drink is to obtain pleasure or to avoid pain. Some drink in order to stupefy themselves, and thus destroy the effect of surrounding external circumstances. Thus we find the advice given in the Book of Proverbs: "Give strong drink unto him that is ready to perish; and wine unto those that be of heavy hearts: let him drink and forget his poverty, and remember his misery no more." The effect of alcohol, no doubt, is to give the individual temporary pleasure and forgetfulness of sorrow; but it is a pleasure dearly purchased, as in most cases it simply increases the misery afterwards, and hurries him along the road to ruin. The taste for alcohol may sometimes be acquired by its being at first taken not to obtain temporary relief from great sorrow and misery, but simply to counteract the effect of petty worry or irritation. One of the circumstances which may tend to lead to this is bad cookery. A savoury meal is much more digestible than an unsavoury one. We have already seen that while gentle stimulation of the stomach aids digestion very much, over-irritation arrests digestion and produces vomiting. Now, the stomach can be affected not only by substances introduced into it, but also by mental conditions. It is well known that bad news destroys the appetite; and grief or disappointed love causes more or less rapid emaciation, and may reduce the strength of the person so much as to render him liable to attacks of some diseases—for example, such as consumption. A disgusting odour will not only destroy the appetite, but cause nausea and vomiting; and on some persons of a highly nervous temperament badly-cooked food has a similar action. Sometimes, too, if a meal, though good in itself, is limited simply to meat and potatoes, a feeling not of hunger, but a want of something else is perceived after it is over; this feeling is not caused by insufficiency of food, but is rather a craving for something to stimulate the digestive secretions. The chief reason why savoury and well-cooked food is more digestible than unsavoury food is that its pleasant smell and taste excite the digestive secretions. This is popularly expressed by saying that something nice "is enough to make one's mouth water." The free secretion of saliva causes the starchy parts of our food to be quickly digested, both in the mouth and stomach; but this is not all. When it reaches the stomach it stimulates the secretion of gastric juice, and the gastric juice, when it passes out of the stomach, stimulates the secretions in the intestines below. Thus, by the introduction of the savoury food, the digestive secretions of the intestinal canal are stimulated one after another; digestion occurs rapidly, and the strength of the body is amply maintained. Badly-cooked and disagreeable food, on the contrary, even if it does not cause nausea, has no such stimulating effect on the secretions: the process of digestion proceeds slowly, and time may be allowed for abnormal fermentation of the food to take place, with the result of producing acidity, flatulence, and intestinal disturbance. It is very unfortunate that the wives of many artisans know little or nothing of cookery, and although the food which they use may be expensive and good in itself, the dishes they serve up to their husbands are by no means appetising. When, in addition to this, it happens to be washing-day, and the odour of soap-suds pervades the house, when children, disturbed in their play, are crying around the room, and the wife herself, tired and worried, is perhaps not in the best of tempers, the conditions for a man's digestion are very far from being favourable. It is no wonder, then, if he should go out and try and get a meal at a public-house, or, at any rate, should try to lessen the effect of the worry by a glass of spirits at the nearest tap. Even when the meal is ample in itself, a sense of want is sometimes felt, if it consists of only meat with potatoes or bread, and a craving is felt for something savoury or stimulating. This craving for stimulants is removed by a glass of beer or of wine, but the same effect is also produced by other savoury substances containing no alcohol. All that is wanted seems to be a stimulus to the secretions, and a little salt put upon the tongue will effect the purpose; still better, perhaps, is dried fruit, a few raisins or a fig, a sweet pudding, or a piece of good cheese—all have a similar action. It is not without reason that people have fallen into the plan of taking puddings or stewed fruits at the end of dinner, and finishing up with cheese or dessert.

It is by no means necessary to have all of these, but one or other is certainly of advantage in aiding digestion. When the meal is very large we find that people are accustomed to give a still further stimulus to their digestive powers by taking a small glass of brandy or curaçoa at its termination; but the wise man will not overload his stomach so much as to require the alcoholic stimulant to aid his digestion; and the remedy for its requirement in the artisan is a better diffusion of a knowledge of cookery, and the use of puddings, stewed fruits (such as American tinned peaches and apricots), raisins, figs, or cheese to conclude a meal.

In atonic dyspepsia, where the digestion is slow and feeble, as in persons debilitated by town life and overwork, a little brandy or whisky and water, wine or beer, may be necessary or advisable at meals; but it is of very great importance that, where this is prescribed by a medical man, he should say definitely how much wine or spirits he intends the patient to take, and for how long a time it is to be continued. For his own sake it is advisable that he should write it down and even keep a copy of it, for it frequently happens that patients who have a liking for alcohol shelter themselves from the remonstrances of friends by saying that they are taking it by the doctor's orders. The medical attendant thinks perhaps that they are taking a single glass of sherry at dinner, while they are taking it not merely with meals, but between meals to the extent perhaps of a bottle of sherry a day. Nor is it always sufficient for a medical man to limit exactly the quantity of alcohol to be taken by the patient, because under one pretext or another this may be exceeded. A good instance of this is the story of the old Scotch farmer who was ordered by his doctor to take two fluid ounces of whisky in the course of the day. This would seem precise enough, but unluckily a fluid ounce consists of eight fluid drachms, and the word drachm has two meanings. To the apothecary, a dram or drachm means the one-eighth part of a fluid ounce, or about a teaspoonful; but a dram to the ordinary Scotchman is equivalent to a nip, which may be a full glass. The farmer, not knowing what a fluid ounce was, waited until his son came home from school, and on learning that it contained eight drams, was greatly delighted, and said that the doctor understood his case. He had always had eight drams a day, and he always wanted eight more. The consequence was that, instead of reducing the allowance of spirit from eight glasses, each holding about two ounces, to one glass, this unlucky prescription increased it to sixteen.

The necessity for limitation as to time is shown by the case of a lady whose friends thought she took more stimulant than was good for her, but she protested that she was taking it under medical advice. To strengthen her position, she told them that she had the prescription; but when her friends, who were still incredulous, asked to see it, they found it was twenty years old. On their asking the lady whether she still continued to take the other remedies the prescription contained, her patience gave way, and she cried, "Do you think I am a fool?"

The greatest quantity of alcohol which a healthy man can take in twenty-four hours without injury has been estimated by Parkes, our highest authority on this subject, at two fluid ounces, or rather less than an ordinary sherry-glassful. This corresponds to about four glasses of port, or five glasses of sherry, madeira, or marsala, or from half a bottle to a bottle of claret, burgundy, hock, moselle, or Hungarian wine. It must be remembered that this is the extreme limit, and that it by no means follows that because a man may take this quantity without being the worse, he will be the better for taking it.

The question is sure to arise, whether it is advisable to cut off alcoholic liquors entirely from persons who have been accustomed to take them freely, and who are at length beginning to suffer from the degeneration caused by them. The opinion which my own observations have led me to form on this point is, that if the degenerative processes have not gone far, and there seems reason to believe that the organs, though beginning to suffer, are still fairly healthy, it may be advisable to cut off stimulants altogether. But this is not the case where the degeneration has gone far. When symptoms of dropsy appear, or where the heart is becoming feeble, or the nervous system markedly degenerated, in persons who have been accustomed to take alcohol for a long series of years, the sudden and complete withdrawal of what is to them, not only a stimulus, but is, from long habit, to a great extent, a food, is likely to be injurious. If they have indulged in it to a great excess, let it be diminished, but not entirely withdrawn.

As we have seen, alcohol diminishes the power of appreciating the relationships of the organism to external conditions, and it thus enables people to get temporary relief from the depression which unfortunate circumstances produce. Poverty and want, shame and misery, render life unendurable to some unfortunates, and their only resource is drink. In some the shame and misery are so great as to be unbearable, and they are sometimes rendered greater by remorse, and by a comparison of present degradation with a respected and happy former life, even although the organism is not depressed by hunger or cold. In others, cold and want increase still further the depression produced by other miserable surroundings; and even in the case of the artisan, of whom we have spoken, unsatisfied appetite intensifies the disturbing effect of small worries. All these conditions tend to create a desire for alcohol, for, as we have already mentioned, alcohol not only lessens the power of the organism to perceive the condition of external circumstances, but the condition of internal organs; thus in Alexis St. Martin the greatly deranged condition of the stomach, which after a single indulgence in alcohol would probably have caused loss of appetite and headache, was not perceived after eight or ten days indulgence, and he felt perfectly well, although he was really ill. Pleasure and pain, happiness and misery, are not entities; they depend upon the relation of the organism to surrounding circumstances: thus we see one person eating with appetite what another would turn away from in disgust, and a child in the gutter amusing itself in great delight with a few stones and twigs, which in imagination it builds into palaces and peoples with princes, while a child of wealthy parents is fretting and disgusted amid the most costly toys. This is to be seen still better, perhaps, when mental disease has completely destroyed the normal relations between the body and the surroundings. The maniac who thrusts his fingers into the fire, laughs delightedly when he sees them blazing (as we have already mentioned), when a sane person would shriek with terror and pain; another maniac fancies himself possessed of enormous strength and boundless riches, when he is hardly able to stagger along and has not a penny to call his own, and may think himself emperor of the world and even Almighty Ruler of the universe, when he is actually confined in a lunatic asylum, and every action is controlled by his keepers. In others, again, an entirely opposite condition occurs, and a man of enormous wealth fancies himself unable to afford even the necessaries of life, and is in constant terror that he will die in a workhouse. And there are not a few people perfectly sane and free from all delusions, who yet suffer from melancholy which they cannot throw off, and yet for which they can assign no reason. They ought to be happy, for they are successful in life; they have no pressing cares; their homes are comfortable, and they are surrounded by loving friends; and yet, in spite of all, they feel low, melancholy, and miserable. Here the condition of depression is obviously in the organism and not in its surroundings. In the case of the wealthy man afraid of the workhouse, this condition may be due to some alteration of the brain which is permanent and cannot be removed; but in others who suffer simply from depression of spirits, the condition is only temporary, for it varies from day to day, and will sometimes disappear entirely. Slight variations in it are probably caused by the effect of the weather upon the body, but the entire disappearance of the melancholy not unfrequently occurs during a holiday, when the person gets plain food and plenty of open-air exercise.

The healthy condition induced by such food and exercise may continue for some months after the holiday is over, and then the person begins again to suffer from the depression which is to him or to her quite unaccountable. We have already seen that the cause of it is something within the sufferer's body, and something, moreover, which is of a temporary nature. In many cases it is really due to poisoning by substances formed within the body, or diffused through the air of his house; in other words, he is poisoned by the products of imperfect digestion, or by sewer gas, arsenical wall papers, or by a mixture of all three. We have had occasion to refer several times to the effect produced upon the circulation, and through it on the general nutrition, well-being, and happiness of the individual by food, or by a small dose of alcohol taken into the stomach and acting reflexly through it on the heart and vessels; thus moderate stimuli to the stomach produce a feeling of well-being, but excessive stimuli arrest gastric secretion and lead to nausea or vomiting. How exceedingly miserable nausea makes one is known to everybody, and no external circumstances, however favourable, can render a person happy while suffering from sea-sickness. The condition of the abdominal organs is thus closely connected with feelings of joy or depression; nor is this to be wondered at, for the same nerve which regulates the movements of the heart sends branches also to almost every one of the abdominal viscera. When the stomach is in a state of slight chronic irritation or catarrh, a feeling of depression and despondency is often felt. But the people whose case we are now discussing are often extremely careful in their diet, and their digestion of such food as they take seems perfect, so that we must look to another organ for an explanation. This organ is the liver; and the Greeks showed much wisdom in connecting with the disorder of its function the depression of spirits, to which they gave the name of black bile, or melancholy (μελαν, black; χολη, bile). All the blood from the stomach and intestines must necessarily pass through the liver before it can again get into the general circulation, and if the portal vein, or the vein through which this blood reaches the liver, be obstructed in an animal it will die very speedily, almost as quickly indeed as if it had been bled to death by opening a large vessel. Thus does a slight interference with the flow of blood through the liver derange the circulation in the stomach and intestines, and a great obstruction profoundly affect the systemic circulation. But this is not all—most of the products of digestion are absorbed from the stomach and intestines by the blood-vessels, and these products must also pass through the liver before they can reach the heart, brain, and muscles; and well it is that they must do so, for the limits of existence in relation to digestion as well as to animal heat are very narrow. Food and poison are much more closely connected than we would at first imagine, and it has been lately found that in the process of digestion food is actually converted into substances which in large quantity act as poisons; butcher's meat, fish, eggs, and albuminous matters generally are converted in the process of digestion into soluble substances called peptones. These peptones, when introduced in large quantity directly into the veins, have the power of completely destroying the coagulability of the blood—at least in dogs; and they greatly depress the circulation, so that the tension of the blood in the vessels becomes much diminished. When the quantity injected is large they completely arrest the secretion of the kidneys, and produce convulsions and death. It almost seems a wonder that we are alive at all, when we consider that if our nutritive processes were insufficient to maintain our temperature, so that it sunk only a few degrees, we should die of cold: if it rose a few degrees, we should die of fever heat; and that at almost every meal we are forming enough poison to kill us if it were only poured all at once into our blood; but fortunately the mechanism of the animal body, although very delicate, is very precise, and though it works within narrow limits, it works within them well.

The peptones formed by the digestion of albuminous food apparently undergo some change in the blood, even in the short interval that intervenes between the intestines and the liver; they have almost entirely disappeared by the time they reach it, and probably their conversion into some other substance, nutritive and not poisonous, ought to be complete before they pass through the liver. Sometimes, however, we know that this is not the case, inasmuch as the peptones are actually excreted from the body by the kidneys. Their passage into the general circulation from functional inactivity of the liver may be regarded with much probability as one of the causes of depression and melancholy: such is probably the case with those people who suffer from nervous depression, weakness, and melancholy, chiefly during digestion, and especially during that period of it when the absorption of the peptones is taking place, that is, about two or three hours after a meal; thus, having breakfast between eight and nine they begin to feel weak and miserable about eleven, and having had luncheon between one and two they are attacked by another feeling of weakness about four. To relieve this condition they not unfrequently think it necessary to take a glass of wine and a biscuit, or a nip of brandy; perhaps, instead of this, they may take some strong beef-tea, and try to keep up the strength by forcing themselves to eat meat three times a day; but this mode of procedure brings no relief. The warm beef-tea, the glass of wine, or the nip of brandy produce a momentary stimulation, and give temporary relief, but the depression soon returns, and these temporary remedies only tend to interefere with its ultimate cure.

A fire may go out from two causes: either because it wants fuel, or because it is choked with ashes; and the fire of life may suffer in a similar way. Some of the poverty-stricken seamstresses in the east of London suffer from depression because they have insufficient food: a little bread with perhaps a scrape of butter—meat being a luxury which is not to be thought of—from week's end to week's end. In them there is depression from lack of food; but in many who are well off, and have but little to do, the nervous depression is even greater, and the vital flame sinks not from lack of fuel, but from accumulation of ash. They think their weakness proceeds from want of food, and they force themselves to eat, and especially to eat animal food, whereas what they want is abstinence and exercise. To tell one of the poor seamstresses, already mentioned, to fast once or twice in the week would be an absurdity, for her whole life is one continual fast; but there are not a few to whom an occasional fast would be a benefit, both physical and moral. More people in this country shorten their lives by over-eating than by starvation; and an unnecessary excess of animal food not only leads to physical disorders, but to an irritable and irascible frame of mind. Instead of trying to remove the depression between eleven and four by taking a glass of wine or spirits, a much better plan is to sip a glass of water, or soda-water, and eat a biscuit. If a greater stimulus than this is needed, a glass of hot *eau sucrée*, with a lemon squeezed into it, may be taken. It is not a matter of indifference whether the water be drunk down at a draught or sipped, for the act of sipping has a very extraordinary effect upon the circulation, as my friend, Professor Kronecker, has shown: during the act of swallowing, the power of the restraining nerves upon the heart seems to disappear; and if any one will count their pulse before they take a sip of water, and while they are taking it, they will find that while they are swallowing the pulse becomes nearly twice as quick as before. It has long been known that by sucking ale through a straw a person becomes drunk much more quickly than when the same quantity is taken at a single draught; and it is probable that this alteration in the circulation by the process of suction has much to do with this curious result.

But in order to obtain a permanent cure a patient must try and get exercise, so as to put the liver into proper condition. The bile which this enormous gland produces is secreted under very low pressure, and a very slight obstruction indeed is sufficient to prevent its exit from the bile duct into the intestine. Its expulsion is usually aided by mechanical compression, because the liver lies directly under the diaphragm; and during exercise it is compressed between this muscle on the one side and the abdominal viscera on the other; these are pressed up against it by the muscles of the abdominal walls. But this exercise, in order to be efficacious, requires to be brisk. When a person is sitting at rest, or even walking slowly along a level road, the abdominal muscles yield as the diaphragm descends, and so little or no compression is exerted on the liver. In running, in climbing, in jumping, in vigorous efforts of any kind, the conditions are different; the abdominal muscles and diaphragm are frequently brought into action at the same time, and thus compression of the liver is effected; thus a quarter of an hour's exercise at lawn tennis, at cricket, at boating, or perhaps even better in riding, is more efficacious in stirring up the liver than an hour and a half, or even more of a languid constitutional walk. Such is the treatment that ought to be adopted, if possible; but where circumstances render exercise impracticable, the plan is to lessen the quantity of animal food, and to increase the action of the liver by hepatic stimulants. The mere sipping of water is a stimulant of this sort; not only has it the extraordinary action upon the circulation already mentioned, but it increases the quantity of bile and causes it to be secreted under a greater pressure, so much so that it will overcome an obstruction to its entrance to the intestine, such as would otherwise have stopped its flow. A glass of Carlsbad water sipped hot in the morning during dressing is very useful also, and, if necessary, recourse may be had to the powerful hepatic stimulants, euonymine, iridine, leptandrine, podophylline, and others, the action of which has been so carefully investigated by Dr. Rutherford.

Besides these causes of nervous depression which affect both women and men, there is another to which women are liable: the periodical disturbances of the organism, and more especially the diseases to which they are liable, sometimes may induce a state of depression, for the relief of which they have recourse to alcohol. They may be led to indulge in spirits, first of all, by taking alcohol to relieve pain or spasm, or simply by using it to relieve feelings of weakness, depression, and melancholy. This desire for alcohol sometimes continues as long as the disease of the pelvic organs is present, but disappears as soon as the proper measures have been taken for its relief.

Other conditions which lead to depression of the organism and melancholy are: absence of light, and the presence of sewer gas, or arsenical emanations. It is usually said that the rays of the sun falling upon a grate will put out the fire, but their effects on the vital flame in animal organisms are just the reverse; they make it burn more brightly, increasing the oxidation in the body, and quickening and enlivening its functions. The rapidity with which oxidation occurs in the body is estimated by the quantity of carbonic acid given off in a given time. Moleschott found that when frogs were exposed to the sunlight they give off much more carbonic acid than when kept in the dark, thus showing that the light increases the oxidation within their bodies. Platen made similar observations on rabbits, but found, further, that in them the effect was produced through the eye. This is very much what we would expect, inasmuch as the fur which covers the animal's body would almost necessarily prevent the light from having any action upon it; when the eyes were covered up the excretion of carbonic acid became less, and when the light was allowed to affect them again the excretion was increased. We do not yet know whether the light acts upon the naked skin of the frog as well as upon its eyes, but it is highly probable that it does so. In man also the exposure of the whole surface to light appears to have a tonic or stimulating action; for when I was in New York some years ago I saw at the Roosevelt Hospital a room three sides of which were made of glass, so that the sun could shine into it with the utmost freedom. This I was told was a sun-bath where convalescent patients were allowed to bask entirely naked in the sun's rays—and I was further told that this sun-bath seemed to quicken their recovery and help them to regain their strength. It is obvious, then, that philanthropists ought to endeavour to secure light as well as air in the dwelling-houses of the poor, and the use of light in promoting health affords an additional reason why vigorous efforts should be made to get rid, as far as possible, of the clouds of smoke and thick fogs which render not only London, but also all our manufacturing towns, so dark and gloomy.

Another unsuspected cause of depression is sewer gas, and poisoning by such gases not only causes diseases of different sorts in the household—sore throats, headaches, coughs, and diarrhœa—but when more diluted they produce loss of appetite, languor, and depression of spirits. It is usually imagined that if no disagreeable smell is felt in the house it is quite safe; but this is not always the case. If bad smells are present we are led to suspect that dangerous gases may be present; but these dangerous emanations may exist without the occurrence of bad smells. In some experiments on this subject, M. Gustave le Bon made a mixture of hashed meat and water, and allowed it to putrefy. He placed a frog in an enclosure with some of the liquid. When putrefaction first began a most fetid odour was evolved, but the frog breathing the effluvium was not injured by it. At this time the liquid swarmed with bacteria, and when injected under the skin of an animal was a most virulent poison. After two months the mixture no longer exhibited such intense poisonous properties when injected under the skin of an animal, and the fetid emanations were greatly diminished. One would naturally have been inclined to think that, as the bad smell disappeared, the danger from the emanations would diminish; but this was not so, for they now proved rapidly fatal to an animal breathing them, although the extremely fetid ones had been innocuous.

Arsenical wall-papers are another unsuspected cause of illness and depression, and their dangerous character is unknown to many, and is disbelieved in by many members of the medical profession. A year or two ago I myself belonged to this number. I received a circular urging united action to prevent the sale of arsenical wall-papers without the purchaser being informed that they contained arsenic. This I threw at once into the waste-paper basket, thinking that the danger alluded to in it was chimerical, inasmuch as I had prescribed arsenic medicinally to others with good results, and had also taken it myself without any injury—the quantities employed in both cases being, I thought, very much larger than were likely to come from a wall-paper. A month or two afterwards I learnt, by sad experience, how mistaken I had been. Having chosen an olive-green wall paper, I asked the vender whether it was free from arsenic or not; and being solemnly assured that it was, I had it put up. In a very short time indeed after it was hung, I began to suffer from dysenteric symptoms, with intense languor and weakness—symptoms which strongly indicate arsenical poisoning. Again I went to the shop where I had bought the paper, and repeated my question whether the paper was free from arsenic or not. "Oh yes, sir," was my reply; "there is no arsenic in any paper which we sell." The symptoms, however, were so clearly those of poisoning that I submitted a piece of the paper to a professional analyst, and he at once sent back the report, "The paper is loaded with arsenic." Although it was a good while before I recovered from the effects of this, I was much more fortunate than a medical friend, whose wife and himself were both nearly killed by the use of arsenical paint; or another medical man whose children died of symptoms which he was only led, after their death, to associate with the arsenic with which the nursery wall-paper was loaded. Whenever the symptoms of weakness, weariness, and depression disappear on leaving home, and are again felt very shortly after returning, the sufferer should not have recourse to alcohol for stimulation, but should at once have the drains and wall papers examined.

Depression, as we have already said, may come on from deficient action of the liver, independently of sewer gas or of arsenical papers; but this is not likely to return so immediately after a holiday is over as when the depression depends upon actual though unsuspected poisoning in the house. In all those conditions of depression, and of consequent craving for alcohol which we have hitherto considered, the cause of it, although unknown to its subject, may be readily enough apparent to a medical man who inquires into the matter. But there are other conditions, much more obscure, which lead to drinking. These are probably connected with the original constitution of the man, with the manner in which the nerve-cells of his brain are arranged, and with the tendencies which he has inherited from his ancestors—certain modes of thinking and acting. Those in whom the will is weak and the emotions strong are more liable to the temptations of alcohol than persons of a harder and sterner nature; but in some persons there seems to be a special tendency to drunkenness—a special craving for alcohol apart from any tendency which the general disposition would lead one to expect. This tendency appears to be due to hereditary want of nervous equilibrium, if we may so call it. This nervous instability shows itself in different ways in different members of a family, or in different branches of a family; perhaps the most characteristic forms being epilepsy, insanity, and drunkenness; thus one member of a family is perhaps noticed to be epileptic, and another is a drunkard. Sometimes the tendency is found, not in brothers or sisters, but in cousins; one cousin, for example, being epileptic, and another a drunkard. There is one form of drunkenness which is, I think, epileptic in its nature: the individual remains perfectly sober for weeks or months together, and then suddenly begins to drink, and remains drunk for several days together; this outbreak is again succeeded by a lengthened sober period. Some years ago I was consulted in regard to a case of this sort occurring in a solicitor's confidential clerk. He was a man of very considerable ability, and the occasional outbreaks of drunkenness would sometimes put a stop to some of the business for two or three days, inasmuch as he was the only man who was acquainted with all the details. Notwithstanding the inconvenience which he occasioned, his services were so valuable that his employers were very unwilling to part with him. The spasmodic occurrence of these fits of drunkenness suggested so strongly to me a case of epilepsy that I prescribed large doses of bromide of potassium, just as one would have done for ordinary fits of this disease, and at the same time moral influence was brought to bear upon him by a clergyman who had acquired considerable influence over him. How much credit is due to the medicine and how much to the moral influence I cannot say; but between the two he was perfectly cured, and has never since had a relapse.

Another case was interesting as showing still more clearly the connection between the two. A gentleman of sober habits went out hunting; was thrown from his horse; he received a severe blow on the head; he was laid up for some time, but again went out three months afterwards, was again thrown, and fell on his head a second time. By these falls two distinct depressions in the occipital region were produced, After the second fall he became subject to occasional fits of drunkenness, combined with epilepsy. Before the fit came on, some change or other could be observed in his countenance, which his wife could perceive, and which warned her of its approach. He then got an irresistible desire to drink, and if he could get spirits would go on drinking and remain drunk for about two days; then he had an epileptic fit. After the fit had passed off, he would remain perfectly sober for some months, when the desire for drink and the fit would again recur. If he were prevented from drinking, the fit came on sooner after the craving appeared than it would otherwise have done, but it would not be so severe.

In all cases where there is nervous instability, indicating itself either in epilepsy or in a tendency to drink, it is much safer for every member of the family to abstain totally from alcoholic liquor; for with some persons in whom this tendency is marked a single glass seems to have the same effect as the first taste of blood in a tiger; it excites a furious, mad desire for more, and although the person may sometimes resist altogether, if he once tastes, his power of self-restraint is destroyed, and he is irresistibly compelled to drink until he becomes completely intoxicated.

Some persons are induced to drink not by the desire to avoid pain, but by the wish to enjoy pleasure. Sensations of pleasure are, as we have said, connected with active circulation and sense of power, and we find that in the Norseman's "Walhalla," the gods and the souls of the happy dead spent their days in the excitement of fight or of the chase, and at night when the circulation had become quiet after the exertions of the day, they again stimulated their flagging pulses by copious potations of mead.

This condition which the Norsemen's fancy pictured as one of perfect happiness after death is what they strove to enjoy as much as possible during their lives. We still find similar conditions among those who have little means of obtaining happiness in any other way. Amongst the mining population of England, for example, we see that too often the working men try to make themselves happy in their leisure hours by getting drunk, and have almost no idea of getting pleasurable excitement in any other way, except perhaps by fighting themselves, or by watching fights between their mates or their dogs. Amongst others the tendency to drink is acquired by the habit of taking what is called "a social glass." In remote districts of the country, such as in the scattered sheep farms in Scotland and in the north of England, there were (at least before the introduction of daily papers and penny postage) few topics of interest to be discussed when friends met together. The events in the neighbourhood were few, and local topics of conversation being soon exhausted, nothing was left for them to do but to drink ; and alcohol had the double charm of aiding conversation and of giving a pleasurable excitement. The same want of topics for conversation still affects those in this country who are unable to read, or do not care to acquire information.

Emulation is a deeply rooted instinct in the minds of men and animals, and success in a contest of any kind is a source of great pleasure, while defeat is one of pain. It is, therefore, not to be wondered at that even when there is neither *ennui* nor want of subject for conversation, those who are fond of the society of their fellows should be induced to indulge in alcohol, if they find that it renders their conversational powers more brilliant, their wit more sparkling, and repartee more ready. They are led to do this not only by the feeling of comfort which alcohol causes in them, but by the distinction and applause which it secures them from their fellows; and to this temptation those who are of a nervous temperament, kindly feelings, and social inclinations are peculiarly liable : good fellows in themselves, their desire to become jolly good fellows is a temptation and a snare. Those of duller temperament, whose powers are not so readily stimulated by alcohol, do not run anything like so great a risk, for in them any pleasure which alcohol may give is probably much less in itself, and is not supplemented by the pleasure arising from successful competition. But it must be remembered that alcohol does not in itself give strength ; it only enables a man to draw more rapidly upon his resources. If the calls are not made very frequently, and time be allowed for complete recuperation between each, no harm may be done ; but if the demands succeed one another rapidly, exhaustion is sure to occur. The brain which has been stimulated by alcohol to unusual exertion, if called upon shortly afterwards will not respond to the demand unless aided by a repetition of the stimulus ; and as it becomes more and more exhausted by the excessive demands made upon it, the amount of the stimulus must be increased. For a while this state of things may go on, but by-and-bye the constant action of the alcohol begins to tell upon the brain ; its powers become permanently diminished, the former brilliancy and ability disappear, and then the unfortunate continues to drink not for the purpose of increasing his powers, but for that of enabling him temporarily to forget his weakness and failure, and the sorrow and disappointment which it occasions him. Each repeated indulgence weakens him, further increases his despondency and vexation, and thus renders the craving for temporary oblivion through intoxication more and more imperative.

But social distinction is not the only object of emulation. In the daily struggle for existence between men engaged in business, success or failure often depends upon clearness of perception, promptitude of decision, and readiness when the occasion arises. Where it is necessary that the man's faculties should be all on the alert, when he knows that the struggle is between himself and other wits as keen or perhaps keener than his own, he is tempted to take alcohol in order to brighten his faculties for the moment and get him successfully over his difficulty. But in the course of business such difficulties arise again and again, and so, if the temptation be once yielded to, the stimulus must be frequently repeated; but the frequent repetition tends to dull the faculties, and thus to render necessary larger draughts as well as more frequent repetition. The men who suffer from temptation of this sort are frequently of harder material and of less emotional natures than those whom we have already mentioned as falling into the snares of social indulgence. They may continue to go on stimulating their powers by frequent small draughts or nips for years together, and though their strong nervous system may resist the direct effect of the alcohol, their other organs suffer, and they die from disease of the liver or of the kidneys. In some the connective tissue increases in the liver (as has already been mentioned), obstruction to the flow of blood through it ensues, the veins of the stomach and intestines can no longer pour the blood into the general circulation, the stomach and intestines become congested, the appetite fails, and when the man goes home after his day's work is over he finds that instead of taking a hearty dinner he is perhaps able only to take a mouthful or two of soup, and hardly any solid food. To sustain his strength, as he supposes, he takes wine or spirits, and thus matters go on from bad to worse.

Sometimes a vessel gives way in the stomach, and vomiting of blood occurs, which is sometimes so severe as to carry off a patient in a few days, or even hours; or the congestion of the intestines begins to be marked. They become flatulently distended, then fluid is poured out into the peritoneal cavity, and the prominent abdomen, at first resonant and tympanitic, gradually gives a duller note on percussion, as it becomes filled with water instead of wind with the increasing dropsy. In others, again, the kidneys suffer, and gradually become small and contracted; their power of excreting solid substances diminishes; but the quantity of water excreted is on the contrary increased, so that the person is obliged to arise for micturition once or oftener in the course of the night. The products of tissue waste, being imperfectly secreted, begin to tell upon the nervous system; there is a feeling of unwonted weariness and languor, often combined with excessive irritability; this irritability is frequently so great as to excite the astonishment of the individual himself, as well as of his friends. He is not only easily worried, but slight mistakes and errors of omission or commission on the part of others, which at another time would have called forth only a mild remonstrance, excite bursts of furious passion. This condition is by no means free from risk, for it is usually connected with a high pressure in the blood-vessels; if these have undergone degeneration, as they usually do in approaching old age, and have consequently become brittle, the high pressure within may burst one of them in the brain and cause apoplexy, giving rise to paralysis and death. Sometimes, instead of such a termination as this, the waste products accumulate in the blood, produce a condition of drowsiness and stupidity, gradually increasing into complete coma, from which the person can never again be aroused. The conditions we have just mentioned are those which occur in men of powerful organism, but in others the effects of alcohol are intermediate between those we have just described and those which are said to occur in men of more emotional temperament. In some men of business, accustomed to alcoholic stimulants, the nervous system, instead of resisting the effects of the poison, begins to fail, and will no longer sufficiently respond to their accustomed stimulus; in consequence of this, they become less successful in business, and lose instead of gaining money. Others again may lose not from any fault of their own, but from circumstances over which they have no control; but the effect of the losses may be the same in both. To escape from the depression which their losses cause, and to enjoy happiness in temporary oblivion, they fly to alcohol. They thus gain temporary relief from misery; but by further weakening their powers, they destroy the last chance which they might have had of retrieving their position, and thus render their ruin certain.

Trials of strength and skill in various games and sports is another subject of competition in which distinction is greatly prized. In such competitions, however, the temptation to take alcohol is reduced almost to *nil*, for there it is found that even slight alcoholic indulgence greatly reduces the chances of success. In them it is necessary that co-ordination should be as perfect as possible, and the effect of alcohol is to lessen co-ordination temporarily when a single dose of it is taken, and to affect it permanently when it is regularly indulged in. When out on the moors, a glass or two of wine taken at lunch will often so derange co-ordination as to spoil a man's shooting for the rest of the day; and while he has made a good bag in the forenoon, he may go on missing bird after bird in the afternoon. Some of the best shots at Wimbledon have been teetotalers, and Dr. Carver, whose shooting is probably unrivalled, has never tasted a drop of alcohol in his life. The necessity for strict limitation of, if not entire abstention from, alcoholic drinks, is universally recognised in training for races, and it is probable that the man who indulged in a glass of brandy before a boat-race would be execrated by all those interested in his success.

But this truth, so universally recognised by trainers, is not invariably known or acted upon by people in general, and when called upon for unusual physical exertions they will sometimes try to remove the weariness which these cause and gain additional strength and endurance by taking alcohol. Those who are engaged in long walking competitions, such as those of Weston and others, are wiser than to take alcohol during their continuance. The action of alcohol during exertion has been well described by Dr. Parkes in his account of the expedition in Ashanti :—" The first effect of alcohol when given in a moderate dose (for example, what is equal to one fluid ounce of absolute alcohol) is reviving, but this effect is transient. The reviving effect goes off after, at the utmost, two and a half miles of additional march, and sometimes much before this; then the previous languor and sense of exhaustion not only return, but are sometimes more intense; and if alcohol is again resorted to, its effects are now less satisfactory. The reviving power is usually not so marked, and its peculiar anæsthetic and narcotising influence can often be distinctly traced. The men feel heavy, dull, disinclined to march, and are less willing and cheerful." In this description we can see clearly both the stimulating and the narcotic effects of alcohol, inasmuch as the temporary stimulant effect was followed by a condition of dulness and exhaustion greater than if the men had taken nothing at all. At first we might be inclined to attribute this only to the men having been enabled by alcohol to use up their reserve force more quickly, but a little further consideration will show that Dr. Parkes was, as usual, right in attributing the exhaustion, at least in part, to the anæsthetic and narcotising effect of the alcohol; for on other days beef-tea was served out to the soldiers instead of the ration of rum, and then it was found that while the beef-tea stimulated them as much as the alcohol, it did not leave behind it any depression or dulness. Some might be inclined to say that this result was due to beef-tea being a food as well as a stimulant. This may, to a certain extent, be true, but, as we shall see afterwards, beef-tea is more a stimulant than a food, and in reality supplies scarcely any actual fuel to the body.

Alcohol is, therefore, not a useful stimulant during prolonged exertion, although it may be taken without harm, or even with advantage, for the purpose of removing fatigue and gaining temporary strength when the distance to be afterwards travelled does not exceed a mile or two at the most.

The effect of alcohol, both when taken in a single dose and when consumed habitually, is modified by active exercise. We all know that exercise warms us. This feeling of warmth, unlike that produced by alcohol, is not due simply to a different distribution of the temperature in the body and to the skin being warmed at the expense of the interior, but is due to the actual development of heat by increased combustion in the body. If we throw into the grate some bad stony coal, which burns with difficulty, we may almost completely put out the fire if it were burning badly before; but if it were previously blazing brightly the new coal will also be consumed, in spite of its slight combustibility—and so it is with alcohol.

When taken by persons leading sedentary lives, and in whose bodies combustion is going on very slowly, it will interfere with the process, and will lead to the grave alterations in the vital organs which have already been described. But when active exercise is taken, alcohol, despite its sparing combustibility in the body, will yet be oxidised in the body. Consequently, fatty degeneration of the liver, heart, and other organs will not occur; and men who are accustomed to constant exercise in the open air, such as shepherds or gamekeepers in the Scotch Highlands, may continue in perfect health and reach a good old age, notwithstanding their consumption of a quantity of alcohol that would bring a man of sedentary habits to his grave in the course of a few years.

The same is true, to a less extent, of men living in towns, but engaged in hard manual labour. The great amount of muscular exertion required by their work enables them to oxidise alcohol with considerable facility, and thus to take a large quantity with impunity; but the other conditions are not nearly so favourable to them as to the shepherd or gamekeeper: the air they breathe is more or less impure, there is an absence of light, and, as a rule, they probably eat more largely, or, at least, consume more animal food. Active exercise and pure air enable the shepherd to oxidise completely all the food as well as the spirits which he puts into his body, and thus his tissues do not become clogged up with waste products. The impure air, and more abundant diet, prevent this oxidation being so perfect in the case of the town labourer, and thus his tissues and organs suffer. Of course, in speaking of town labourers, we take them as a large class which includes many subdivisions. In some of these poverty prevents the diet from being anything but extremely meagre, and thus the action of alcohol may in them be considerably modified.

The effect of alcohol is modified also by the condition of the stomach in respect to fulness or emptiness. When the stomach is empty the alcohol comes more readily into contact with its whole surface, and thus exercises a more powerful reflex action on the heart. It is also absorbed more quickly and in a more concentrated condition, and thus produces a greater effect upon the brain. On this account a quantity of alcohol taken fasting will sometimes completely intoxicate a man, when the same quantity taken after a hearty meal would have had comparatively little effect. When a glass of spirits is swallowed immediately after a meal it is at once diluted by the fluids present in the stomach; it becomes mixed up with the food, and so is brought to a much slighter extent, and in a much less concentrated condition, into contact with the walls of the stomach; its reflex effect upon the circulation is, therefore, much less. At the same time, from its intimate mixture with the large quantity of material in the stomach, it cannot be absorbed very readily, and so its effect upon the brain is very much slighter.

For if we disregard the reflex effect produced by any drug upon the other organs through its local action upon the stomach, we find that its effect upon them is in proportion to the quantity circulating in the blood. Now this quantity depends upon two things—or, perhaps, we ought more properly to say upon three. It depends, first, on the rapidity with which the drug is absorbed into the blood; secondly, on the rapidity with which it is destroyed in the blood or tissues; and, thirdly, on the rapidity with which it is excreted. Now when alcohol is absorbed quickly from the stomach there is little or no time allowed for its destruction in the blood or tissues, nor for its elimination from the body by the lungs, or by the kidneys. The quantity present in the blood, therefore, increases rapidly, and the brain and the heart are much affected. But when it is absorbed slowly, time is allowed for its destruction in the organism, and for its elimination by the lungs and kidneys, so that the quantity present at any moment in the blood is comparatively small, and its action upon the heart and brain is but slight.

The state of concentration or dilution in which alcohol is swallowed has also considerable modifying power. When concentrated, its local action on the stomach, and its consequent reflex action on other organs, is much greater; when diluted, its local action and reflex effects are both much less. When concentrated, it is said to be absorbed more slowly than when diluted; but when only moderately diluted, its comparatively small bulk enables it to be more quickly absorbed than when much diluted, for then its much greater bulk prevents its absorption from being effected so quickly, and allows more time for its destruction and elimination. The effect of diluting alcohol is, therefore, on the whole, to diminish both its local and general action in much the same way as when it is taken upon a full stomach.

The action of alcohol is aided by heat and retarded by cold. Macnish says that he has seen people who could drink eight or ten glasses of raw spirits at a sitting without feeling them much, become perfectly intoxicated with half the quantity made into toddy by admixture with hot water and sugar. He attributes this, but I think wrongly, to the stomach being habituated to the strong spirits, and not to the diluted spirits. The effect is rather to be attributed to the heat of the mixture, which by stimulating the heart accelerated the circulation, and thus aided the effect of the alcohol; though perhaps the greater effect may also be partly due to the more rapid absorption of the toddy than of the raw spirits.

But hot toddy has sometimes a soothing and sudorific, instead of a stimulating, action; and persons who suffer from sleeplessness sometimes find this relieved more readily by hot brandy and water than by any narcotic. The reason of this is, that the condition of sleep is associated with a scanty supply of blood to the brain, whereas mental activity requires an abundant supply. But the quantity of blood in the body is limited, and if more goes to one part less must go to another. Consequently, if there is much in the stomach there must be little in the head, and *vice versâ*. Everybody knows the drowsiness which comes on after eating, and knows also the effect of hard mental work immediately after a meal in hindering digestion. Long ago this was explained by Mayow on the supposition that thought and digestion were both carried on by what he called "vital spirits." These spirits came down from the brain to the stomach in order to digest, and after the work was done went back to the brain, in order to think; and as they could not be in both places at once, digestion and thought could not go on at the same time. If, in place of Mayow's "vital spirits," we read "blood," his theory will very nearly represent the opinions of the present day. When digestion is going on the vessels of the stomach and intestines become filled with blood; the supply which is available for the brain is therefore diminished, and the person goes to sleep. When the brain is active it takes more blood, and consequently there is less for the stomach; so that mental activity after a meal interferes with the digestion by drawing away the blood from the stomach.

A glass of warm spirits and water taken at night into the stomach dilates the vessels there, and by thus drawing blood away from the brain enables the person to sleep. But the mixture of spirits and water has the disadvantage that it tends to stimulate the heart, as well as to dilate the vessels of the rest of the body; so that, if it does not produce sleep, it will make the person more wakeful than before. A similar result, and sometimes a better one, can therefore be obtained by using, instead of hot spirits, a large bowl of weak beef-tea or of panada. Heat itself is a stimulant to the heart, and as we do not wish the heart stimulated, but only the vessels of the stomach dilated; while these things, then, should be warm, they should not be too hot. A wet compress over the abdomen is sometimes better than anything taken internally, and is especially useful for sleeplessness in children. Where a local compress fails, a wet pack sometimes succeeds.

What I have just said regarding the effect of heat and cold may seem at first sight to be contradicted by the fact that persons who have been drinking spirits in a warm room without experiencing any marked effects may become suddenly intoxicated when they go into the cold air. Two reasons might be assigned for this: one is that, from the coldness of the air, the elimination through the lungs may be checked, while absorption is still going on from the stomach, and thus the amount of alcohol in the blood is increased. The other and probably the true reason is, that the cold air acting upon the vessels of the skin, which have not yet been completely paralysed by the alcohol, causes them to contract, and thus drives more blood to the internal organs and to the brain. The brain thus receives alcohol in larger quantities than before, and the paralysing effect of the alcohol upon it is thus more rapidly produced.

In one of his charming stories from German history, Gustav Freytag describes a drinking duel between the hero Ingram and another German. Whoever first became intoxicated was declared vanquished, and the great object of each was to prevent their attention being distracted, because, when the parties were at all equally matched, the least thought or emotion at once caused intoxication, and consequent defeat.

The effect of attention may be explained in the same way. It is known to habitual drunkards that if they wish to drink much they must allow others to do the talking, for they will become affected much more readily by alcohol if they join in the conversation. Now, conversation implies mental exertion, and mental exertion is connected with a freer flow of blood to the brain. The freer the flow of blood, the more alcohol will be carried by it to the brain, and therefore the more rapidly will the mental faculties suffer.

FORMS OF ALCOHOL.

Having considered the modifications produced in the action of alcohol by the alterations in the organism, we have now to consider its effect as modified by the different forms in which it is taken. The chief forms are: spirits, wine, and ales. Each of these three classes contain several subdivisions.

Alcohol consists of the three elements: carbon, hydrogen, and oxygen. For convenience sake the initial letters of the Latin names of the elements are used to designate them. But these letters indicate more than simply the presence of the element: they indicate its presence in a given quantity. For it has been found that elements always combine in definite quantities, or multiples of these quantities; and these proportions are: 12, 1, and 16, for carbon, hydrogen, and oxygen respectively. C, then, always signifies 12 parts by weight of carbon; H, one part by weight of hydrogen; and O, sixteen parts of oxygen. These numbers are called the combining or atomic weights of the elements, and are supposed to represent the relations between the weights of the smallest possible portion or atom of each substance.

We may have not only union between single atoms of each element, but between several atoms; thus in alcohol we have union between two atoms of carbon, six of hydrogen, and one of oxygen. This is represented by a formula thus: $C_2 H_6 O$, and this formula shows us, not only that carbon, hydrogen, and oxygen are contained in alcohol, but that there are 24 parts by weight of carbon, six of hydrogen, and sixteen of oxygen. When it is put into a spirit lamp and burned, it unites with the oxygen of the air and forms carbonic acid and water, heat being given off at the same time. The chemical changes which occur between the atoms of carbon, hydrogen, and oxygen in the process of combustion is represented by the formula :

$$\overset{\text{Alcohol,}}{C_2\, H_6\, O} + \overset{\text{Oxygen of Air.}}{O_6} = \overset{\text{Carbonic Acid Gas.}}{2\, C\, O_2} + \overset{\text{Water.}}{3\, H_2\, O}$$

Alcohol has been prepared chemically in several ways. It has been found in small quantities by a direct union of the elements; but, practically, it is always made by the fermentation of sugar. All kinds of sugar are not alike : one which is called grape sugar, and which may be seen occurring in small hard masses in raisins, has the formula $C_6\, H_{12}\, O_6$. Another sugar, called from its source cane sugar, may be also used for preparing alcohol, but in the process of fermentation it first is changed into grape sugar, and afterwards into alcohol.

The change which occurs in grape sugar is that it splits up into alcohol and carbonic acid ; the alcohol remains in solution and the carbonic acid passes off. This gas has powerful asphyxiating properties, and it is from it that so many deaths by suffocation have occurred in brewers' vats. The formula representing this change is—

$$\overset{\text{Grape Sugar.}}{C_6\, H_{12}\, O_6} = \overset{\text{Alcohol.}}{2\, C_2\, H_6\, O} + \overset{\text{Carbonic Acid Gas.}}{2\, C\, O_2}.$$

When the mixture of alcohol and water, which is produced by the fermentation of the solution of grape sugar, is subjected to distillation, the alcohol passes off much more easily than the water, and so a strong spirit is obtained in the distillate, a great portion of the water remaining behind ; the distillate, however, still contains some water, from which it may be freed by mixing with lime and re-distilling.

Pure or absolute alcohol is lighter than water, and has a great attraction for it, so much so that it will absorb it very readily from the air ; when mixed with water it unites quickly with it, and gives rise to heat. It burns very readily with a blue flame and with no smoke. The more water that is mixed with it the less readily does it burn, until at length it will not burn at all; but will rather put out the fire. This property was formerly employed as a rough method of ascertaining its strength : a little of the spirit was poured on to gunpowder, and set on fire; if the spirit was strong the gunpowder exploded, but if the spirit was weak it damped the gunpowder so much that it would not take fire; when the gunpowder exploded the spirit was said to be *above proof*, and when it would not explode the spirit was said to be *under proof.*

We will first compare the action of the divisions—spirits, wines, and ales—with each other, and then we will compare the action of the different kinds of spirits, wines, and ales among themselves. The first difference we note between spirits and the other two groups is that of concentration. Almost all kinds of spirits contain from about 40 to 58 per cent. of alcohol by weight, wines from 8 to 20, and ales 1 to 10. Thus we see that, roughly speaking, wines are as a rule twice as strong as beer, and spirits twice as strong as wines. A glance at these numbers will show that the strong ales are stronger than the light wines.

Spirits are composed chiefly of alcohol and water, though each kind of spirit has a peculiar flavour which it owes to another kind of alcohol or ether. Wines contain a larger proportion of ethers, colouring matter, and some tartrate of potash. Ales differ from the other two in containing less alcohol, and little or no ether; but contain some sugar and some gluten, as well as a little mineral matter. They almost invariably contain also the extract of hop. The distinction between ale and beer originally was, that beer contained hop and ale did not; but now both beers and ales contain hop; and the difference is simply that the proportion of the bitter extract of hops in ale is less than in beer. It is therefore sweeter, as well as of a lighter colour.

From their greater concentration spirits have a much greater local action, and produce more powerful reflex effects than wines or ales. When applied to the unbroken skin alcohol evaporates rapidly, and especially when the part is fanned or blown upon so as to increase the evaporation alcohol produces a sensation of great cold. If its evaporation is prevented by placing over it a piece of waterproof tissue, it penetrates through the scarf skin, or epidermis, to the true skin below, and there has a similar action to what we have already described as occurring in the mouth. It partially and temporarily coagulates the albuminous substances, and produces irritation and redness. In this respect, too, brandy or whisky will have a similar effect to that of pure alcohol, though not quite so powerful.

When taken into the stomach, evaporation being prevented, spirits also cause much local irritation. Strong wines have little or no effect on the unbroken skin, but when taken into the mouth, acting more readily on the delicate mucous membrane, they produce a sensation of warmth, and this is sometimes felt to a disagreeable extent as they pass down the gullet in persons who are suffering from abnormal irritability of that part.

The alcohol in ales and beer is so diluted as to produce no action on the skin, and but little on the mouth. The hops and carbonic acid which they contain cause, however, a pleasing stimulus by their sharpness and transient bitterness. The bitter of hops differs from that of other bitters, in producing a very temporary effect upon the organs of taste, and to this quality its pleasant effect is chiefly due. The sensation of bitterness is in itself disagreeable to most persons, and when, like that of strychnia, it is persistent, it becomes very disagreeable. Quinine also, when taken in nearly a neutral solution, produces a very persistent and disagreeable bitter taste. But if it is taken with sufficient acid to keep it thoroughly in solution, even when it comes in contact with the alkaline mucous membrane of the tongue, and when it is followed by a draught of water, it leaves upon the tongue, instead of a bitter, a pleasant sweetish taste. The taste of the quinine itself is disagreeable, but the after-taste is very pleasant; and the bitter of hops, being very transient, leaves a pleasant impression.

The local effect of alcoholic drinks upon the stomach is like that upon the mouth. It is powerful in the case of spirits, moderate in the case of strong wines, and slight in the case of weak wines and ales. When a man wishes to stimulate his digestion, and prevent something which he has taken from disagreeing with him, as, for example, when he has taken a lobster supper, he takes a small glass of spirits, and not several tumblers of beer. The reflex action on the circulation is also great in the case of spirits, moderate in that of strong wines, and small in that of weak wines or ales. When a person is fainting, and we wish to stimulate his circulation quickly, we give him a glass of spirits or of port wine, rather than half a tumbler of claret or a glass of ale.

The effect of wines, beers, and spirits on the process of digestion in the stomach is one of very great importance indeed, but is very difficult to decide satisfactorily. On the one hand, we know that alcohol in certain quantities will harden meat, and thereby interfere with its digestion; that it will further precipitate pepsine and peptones; and that in large quantities it will also stop the secretion of gastric juice, increase the secretion of mucus, and even lead to vomiting. On the other hand, we know that small quantities are among the most powerful stimulants to the secretion and movements of the stomach which we possess, and therefore we are inclined to suppose that they would greatly facilitate both the digestion and absorption of food.

The result of special experiments is here contradictory; and the result of the experiments made on a large scale by people in general is also contradictory; for while the great majority of people in Europe, at least, drink alcohol in one form or another, with such of their meals as contain albuminous matter in the form of flesh or cheese, a certain number find they are better without alcohol in any form, and that when taken with their meals in small quantities and in a diluted form it deranges their digestion. To settle this difficulty some experiments were made a short while ago by Buchner under the direction of Professor Leube.* These experiments were made in two ways—first, by treating boiled white of egg with a digestive fluid in glasses maintained at the temperature of the body. To the digestive mixture in one glass no alcohol was added; to the others alcohol was added in various proportions and in different forms, as wine and beer. The result of these experiments was, that when alcohol was added in quantities only sufficient to form 10 per cent. of the whole liquid in the glass, it had no effect upon artificial digestion, but that as the quantity was increased from 10 to 20 per cent., the digestion went on more and more slowly, and that when more than 20 per cent. was added, digestion was entirely arrested.

Experiments with wines showed that they interfered with digestion to a greater extent than could be explained by the quantities of alcohol they contained. Contrary to expectation, the French red wines interfered more with digestion than the white German wines. One of the worst of all was Marsala, and one of the least objectionable was sparkling Hock. The reason why wines should interfere more with digestion than a corresponding quantity of alcohol was not determined.

Beer also, contradictory to expectation, was found to interfere very much more with digestion than a corresponding quantity of diluted alcohol, and this result was possibly due to the salt, and especially to the phosphates, it contained.

But experiments made with digestive fluids in a glass, while they may give us an approximate idea of what is going on in the stomach, do not correspond at all exactly to the conditions in the living body. For in the stomach we have to consider not merely the solution of the food in the gastric juice, but the secretion of this juice itself, the movements of the stomach, and the rapidity of absorption. In order, therefore, to obtain some trustworthy data regarding the action of various forms of alcohol on digestion in the stomach, Buchner washed out the stomach of some patients by means of a syphon six hours after dinner, and saw whether any undigested remnants of the meal were still present after that interval. Sometimes he allowed them to drink water alone, at other times beer or wine, with their dinner, and drew his conclusions regarding the effect of these drinks upon digestion from the presence or absence of any food in the stomach when he washed it out. From consideration for his patients, who were almost entirely women, he made no experiments either with alcohol, with brandy, or any other form of spirits, but only with beer and wine. The results that he obtained were, that both wine and beer, even in small quantities, interfered with digestion; but when the stomach was healthy, this interference was not so great as in the experiments made with artificial digestion in glasses. Whenever the stomach was deranged, and gastric catarrh was present, the results of experiments on the living body approached more nearly to those on artificial digestion in glasses, and the deleterious influence of wine and beer upon digestion was increased to such an extent as sometimes to arrest it altogether. This result corresponds with the clinical observations of Professor Leube, who has been accustomed for years back to avoid every form of alcohol in cases of gastric catarrh; or if he thought necessary to administer it, has only done so by means of enemata.

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* "Deutches Archiv für klinische Medicin," Vol. XXIX., p. 537.

The injurious effects of alcoholic liquors on the stomach and intestines have been particularly studied by Professor Leudet ("Lyon Médical," tome xli., p. 123). These effects differ according to the manner in which the intoxicating liquor is taken. People in easy circumstances take it regularly and continuously without ever getting drunk; artisans, on the contrary, take considerable quantities of alcohol at one time, once or twice in the week. These two modes of absorption produce different lesions. M. Leudet has not paid any attention to the different kinds of alcohol, but thinks that it is in the continuity of its deleterious action rather than in the kind taken, that we must look for the cause of the lesions in the easy class. In the artisan class, where the alcohol is drunk rapidly, gastro-enteritis is found, which is of a more or less acute character.

Among well-to-do people, gastritis of a superficial catarrhal character is chiefly found, and enteritis occurs especially among wine merchants. In fact, the man who never gets drunk, but who is continually drinking, has always loose and never firm motions. This enteritis and this liquid condition of the motions may last for twenty or thirty years; the motions are catarrhal and not dysenteric. On the other hand, the workman who gets drunk once or twice a week, but hardly touches liquor at other times, suffers rather from constipation. The well-to-do drunkard often suffers from a tendency to bleed from the nose or from the stomach, from the kidneys or from the liver; he has also a tendency to atheroma. Among rich people glycosuria may occur at the age of thirty-five years. In such persons enteritis is very serious, and is accompanied by hepatic complications, such as hypertrophic cirrhosis, which may last seven or eight years, while such affections are very rare in the artisan.

The effects upon the nervous system of wines, beers, and spirits are due: first, to their reflex action on the circulation; and secondly, to their effect upon the brain and nerve centres after absorption.

The stimulant effect of spirits upon the circulation is greatest, and that of beer is least.

The action upon the nerve centres is also most rapid in the case of spirits, and slowest in the case of beer. On this account, the restraining powers of the nervous system being paralysed, while the lower centres are still undergoing greater stimulation, there is a greater tendency to wild excitement from spirits than from either wines or beer. Strong wines have an action similar to spirits, whereas weak wines more resemble beer.

In the case of wines, however, the stimulant effect of the alcohol which they contain is modified by the ethers which give to the wines their bouquet. It is probably in consequence of this that wines have a tendency to cause hilarity and an excitement of the emotions, feelings, and thoughts, whose effects are confined to the individual himself, rather than the tendency to movements of aggression upon others, which spirits have a tendency to produce.

The effect of alcohol in beer is modified by the hops. This substance has a somewhat soporific action, and beer has therefore a greater tendency to produce drowsiness and sleep than either spirits or wines.

The effect on the general nutrition of the body of wines and spirits is also different. The different appearance of the spirit and beer drinker has been illustrated by Hogarth in his "Beer Lane" and "Gin Alley," where he depicts the beer drinker as large, fat, and bloated, the gin drinker as thin and emaciated. As a good example of the wine drinker, we may take the gouty old Squire in the first picture of the "Marriage à la Mode." There we see him neither thin and emaciated, nor fat and bloated, but with full, rounded, firm cheeks, smooth skin, and a general well-fed, well-cared-for look. Unlike the gin drinker, his body is amply nourished; and, unlike the beer drinker, he has no tendency to the accumulation of waste *non-nitrogenous* products in the shape of fat. He, too, suffers, but his sufferings are due to the accumulation of nitrogenous products. Excess of uric acid and urates in his tissues render him irritable and choleric, while at the same time they cause gouty inflammation in his toes, which chains him to his chair like a prisoner, and occasionally subjects him to the tortures of the Inquisition.

Perhaps the most noticeable instance of the effect of the substances combined with alcohol in certain forms of spirits is to be found in the action of absinthe. This consists of strong spirit flavoured with oil of wormwood, and this oil has a marked physiological action of its own. Absinthe, when given in small doses to animals, causes giddiness, accompanied by an abrupt succession of muscular jerks, as if numerous electric shocks were being passed through the animal. In larger doses it produces epileptic convulsions, and causes also delirium with hallucinations. This delirium comes on quite suddenly, instead of coming on gradually like that of alcohol, and the hallucinations produce agitation and appearances of anger or fright in the animal. In man, the muscular shocks and giddiness which are so perceptible in animals also occur to a slight extent, but are less marked. Unless one were on the watch for them they might pass unnoticed, being represented simply by trembling and giddiness, which might be regarded as due to the alcohol alone. But when intoxication is complete, it is accompanied by epileptic seizures which are not produced by alcohol.*

These convulsions are due to the action of the absinthe, not upon the cerebrum, but upon the medulla. They usually terminate favourably, but in some cases they occur in rapid succession, with intervals of only five or ten minutes between them. Then the case is very grave, and at the third or fourth attack death may occur; or the person may remain in a state of coma ending in death.

Brandy ought to be made by the distillation of wine, and when prepared in this way is one of the purest and least injurious forms of spirit. It then contains, in addition to alcohol and water, small quantities of acetic, œnanthic, butyric, and valerianic ethers, and small quantities of grape sugar, colouring matter, tannin, and acid.

Its action, when pure, is very much like that of pure alcohol, although probably the ethers present in it render it slightly more stimulating to the secretion of digestive juices, and tend to render the intoxication it produces more gay and less furious.

But a great deal of brandy is simply made from spirit by the addition of some bitartrate of potash and prunes, acetic ether, tannin, and burnt sugar. Sometimes a little real brandy is added to it, and sometimes an artificial mixture of œnanthic ether and other substances, made by distilling palm oil with sulphuric acid and spirit. Such brandy as this is of course much more injurious, both to the nervous system and stomach, than the pure spirit.

Whisky is prepared by the distillation of malt, and it contains fusel oil, or amylic alcohol, in addition to ordinary alcohol. This fusel oil is much more injurious to health than ordinary alcohol, being, according to Rabuteau, fifteen times more powerful. Its vapour causes aching and heaviness of the head, and in animals will produce complete anæsthesia. It seems probable that in old whisky a good deal of the fusel oil is converted into ether, or at least enters into some compound in which it is less injurious than it is in new whisky. New whisky appears to have a much more powerful and injurious action upon the brain than old, and seems especially to produce a greater tendency to violence. The observations made on the effect of very old whisky are not numerous. A friend of mine told me that on one occasion, while dining with a gentleman who had some exceedingly old whisky, the guests complained that it was so old that it had lost its strength. It had no fiery taste, nor did it seem to produce any effect upon their intellects while they sat drinking it. But when they rose to go to the drawing-room, they found they were hardly able to walk, the cerebrum seeming to have been left almost unaffected, while the functions of the cerebellum were greatly impaired. In considering this observation, however, we must be careful not to attribute the effect altogether to the quality of the whisky, but partly to the form in which it was taken. It had been mixed with hot water, and gradually sipped, so that its action was distributed over a length of time; if taken pure it might have had a different action.

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* "On Alcoholism," by Dr. V. Magnan, translated by W. S. Greenfield, M.D., pp. 22 and 73. London: H. K. Lewis.

Curious differences are said to exist also in the action of different kinds of liquors on the equilibrium when taken in excess. Good wine or beer is said to make a man fall on his side, whisky, especially Irish whisky, on his face, and cider or perry on his back.* These disturbances of the equilibrium correspond exactly to those caused by injury to the lateral lobes, and to the anterior and posterior part of the middle lobe of the cerebellum respectively.†

The greater excitement and tendency to fury produced by new whisky may not be entirely due to a difference in the mode of action between fusel oil and alcohol, but may be partly caused by the more powerful intoxicating properties which the admixture with the strong fusel oil imparts to the spirit. For where intoxication is produced rapidly there is usually a greater tendency to violence, and this tendency is also more marked in powerful and muscular individuals.

Gin is a spirit flavoured with juniper berries, and also in some cases with cardamom, grains of paradise, coriander seeds, cassia buds, angelica root, calamus, and orris root. The chief effect of these substances in modifying the action of the alcohol in the gin is not so much exerted on the nervous system itself as upon the excretory organs: the kidneys being stimulated by the oil of juniper to greater functional activity, so that alcohol also may be more rapidly eliminated from the body in this form than is the case with other kinds of spirits.

Rum is obtained by the distillation of molasses, and is usually kept for a long time in oak barrels. It is said thus to acquire a larger quantity of astringent matter than other forms of spirit, to have a less irritating action on the stomach, and to be more useful both in gastric and pulmonary catarrh than other spirits.

Koumiss is an alcoholic drink which the Tartars prepare by fermenting mare's milk. It is used both in Russia and this country, but its use here is almost confined to invalids.

The effect of continued indulgence in spirits leads to chronic disease of the various organs of the body. The brain suffers; and its functions, which are temporarily paralysed during intoxication, are gradually but permanently weakened in much the same order by long-continued indulgence. Thus the judgment becomes less clear, the will less powerful, and the sense of the individual's relation to others much impaired. He becomes vacillating, more selfish, and less true. In some cases, indeed, the tendency to untruth becomes so great that no reliance whatever can be placed upon the person's word. Sometimes it is doubtful whether the lying is deliberate, or whether it is really due to what one sometimes sees in children—a complete inability to distinguish between the facts of the external world and the creations of their own fancy. Even in healthy adults we find this difficulty under exceptional circumstances. When one is asked regarding an event which happened some years ago, he will probably give a perfectly correct answer. But if first one, and then another, and perhaps a third, says to him, "Are you quite sure it was so-and-so?" "Did it not happen in such-and-such another way?" he may begin to doubt the truth of his recollection, and finally believe that the occurrence took place in the way suggested by others. His imagination, awakened by his friend's questions in this case, may completely overpower the correct recollection which he has of the facts as they actually happened. In children, the imagination, without any suggestion from without, appears sometimes to overpower the recollection. In drunkards the same is apparently the case, and this is aided by the impairment of memory, which is also one of the consequences of chronic alcoholism.

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* Shorthouse: Baily's "Magazine of Sports," 1880, Vol. XXXV., p. 396

† Ferrier: "Functions of the Brain," London, 1876, pp. 94 and 96.

The physical lesions to which these mental changes are due appear to consist partly in alteration of the vessels which supply the nerve centres with blood, and partly to alterations in the nerve centres themselves. The nerve cells and fibres, to which the activity of the nerve centres is due, are held together by connective tissue. In chronic alcoholism this becomes much increased, and, pressing on the nerve cells and fibres, causes them gradually to waste away.

Besides those alterations in the character and mental powers just described, headache, weight in the head, buzzing in the ears, and giddiness occur frequently in chronic drunkards. They suffer also from numbness, tingling or pricking in various parts of the body, especially in the soles of the feet and palms of the hands, and sometimes in the leg and arm of one side. Sometimes there is greater, sometimes less, sensitiveness to impressions made upon the surface of the body; there may be weakness or trembling of the extremities; and the bladder and rectum may be affected in such a way that their contents are either allowed to escape involuntarily or spasmodically retained.* The alterations in the stomach and intestines occasioned by alcohol, and the symptoms they produce, have already been mentioned.

The marked difference between the appearance presented by the spirit-drinker, the wine-drinker, and the beer-drinker, as exemplified in Hogarth's pictures, is probably partly due to the effects of these different drinks on the alimentary canal, and partly to their effects upon tissue change.

The alcohol in spirits, in wine, and in beer, after it has once been absorbed, will tend to prevent the combustion of other substances in the body; and, undergoing combustion itself, will to some extent act as a food. But the local effects which it produces on the stomach and intestines, when taken in the form of spirits, will prevent other food from being eaten or assimilated to a sufficient extent, and thus the person will be more or less starved, and become thin and miserable. This will not always be the case; and so one may find that at one period the spirit-drinker may present a well-nourished appearance, similar to that of the wine-drinker, or may be even bloated like the beer-drinker. So long as the stomach and intestines are not injured by the spirit, and so long as the drinking customs of the individual have not reduced him to such poverty as to prevent him from getting as much food as he

* Magnan on Alcohol, p. 155.

wants, the nutrition of the body may not suffer, or may indeed appear to be increased; but when either the digestion is destroyed by continued alcoholism or the circumstances of the drunkard lessen his supply of food, then emaciation will occur.

Wine has a less powerful local effect upon the stomach and intestines, and is less likely to destroy the digestive powers than spirits. At the same time it does not contain any nutritious substances in addition to alcohol, and so it does not tend of itself to fatten. Consequently the wine-drinker is neither emaciated like the gin-drinker, nor bloated like the beer-drinker.

As the beer-drinker takes beer in addition to other nutriment, he has a tendency to become fat and bloated at one time, although he may afterwards become thin and emaciated, from his digestion also suffering like that of the spirit-drinker. Notwithstanding the apparent stoutness and strength of beer-drinkers, they are by no means healthy. Injuries which to other people would be but slight are apt to prove serious in them; and when it is necessary to perform surgical operations upon them, the risk of death is very much greater than in others. On carefully looking at the beer-drinker, we see that instead of his flesh being firm, the fat which overloads it is of a somewhat soft consistence, as if the cellular tissue did not contain firm fat alone, but contained moisture along with it. The constant use of alcoholic liquors, indeed, has a tendency to produce watery exudations, either in the cellular tissue or in the cavities of the body generally. This becomes evident in the later stages of drunkenness in the form of dropsy, and has given rise to the old proverb, *Vivit in vino moritur in aqua.* (He who lives in wine dies in water.)

At first the fat, which is very soft, is deposited chiefly under the skin, between the muscles and in the abdomen. In the later stages, when the individual begins to waste, its place is taken by a sort of gelatinous mass, and at a still later stage dropsy occurs. The skin itself is at first soft, with a slight satiny feeling, from which I have seen Professor Neumann discover the alcoholic tendencies of a patient; and perspiration is easily induced. Later on, the skin becomes thick and discoloured, sometimes red and sometimes sallow, and becomes liable to various diseases, the best known of which is acne rosacea, often called bottle-nose. Besides this, the skin may be affected with inflammation of various sorts, leading to the formation of ulcers, vesicular, scaly, or pustular eruptions, boils, and abscesses.

Besides rendering men more liable to death from injuries, or from surgical operations which would otherwise have been recovered from, alcohol tends indirectly to induce diseases. Some of these have already been mentioned—viz., delirium tremens, mania, degeneration of the nervous system, and chronic catarrhal conditions of the stomach and intestines. The morning vomiting and chronic gastro-intestinal catarrh which occur in drunkards have already been described. This catarrhal inflammation not unfrequently leads to ulceration. But besides these affections, alcohol, more especially perhaps in the form of gin, and to a less extent in that of other kinds of spirits, tends to produce degenerative changes in the liver, lungs, and probably in the kidneys.

These changes are chiefly of two kinds—firstly, the increase of fibrous tissue already described, which tends to press upon the proper structure of the organ, and causes it to waste away; secondly, a fatty transformation by which the tissues which ought to compose an organ are transformed more or less completely into fat.

The liver being thus affected leads to indigestion, and later on to bleeding from the stomach or intestines, and to dropsy. The kidneys undergoing degeneration, the excretion of the waste products of the body is interfered with, and their retention in the body leads to a form of poisoning, the patient becoming comatose and dying in stupor.

Spirits have a tendency to cause both forms of degeneration, fatty and fibrous, but more especially the fibrous form. Beer has a tendency to cause chiefly the fatty form of degeneration. Nor are wines free from ill effects, as we see from the figure in Hogarth's picture already alluded to, which we have taken as typical of the wine-drinker. Port wine more especially tends to produce gout; but other wines are not free from this tendency. In gouty subjects, or those who suffer from rheumatic gout, a single glass of port wine will often produce painful twinges, and a similar effect is not unfrequently noticed from hock. Such persons can sometimes drink claret or spirits in moderation with little or no bad effect, but occasionally rigid abstinence from these also is necessary. Dr. Garrod says that the use of fermented liquors is the most powerful of all the predisposing causes of gout—nay, so powerful that it may be questioned whether gout would have ever been known to mankind had such beverages never been indulged in.*

The different effects of spirits, wines, and ales in producing gout is seen by comparing the number of cases which occur in different countries. Sir Robert Christison, during thirty years' experience in the Royal Infirmary at Edinburgh, only met with two cases of gout, and both of these were fat and overfed English butlers. Dr. Hamilton, during the same time, had only two cases, and Dr. Gregory had only two, out of 2,200 patients. In other parts of Scotland, as well as in Ireland, where the people drink whisky, gout is also absent; and Russians,† Poles, Swedes, and Danes are also free from it, although they drink large quantities of spirits.

The greater power of wine than of small beer to produce gout is shown in the observations of Van Swieten on the Dutch, and Linnæus on the Laplanders.‡ Both were comparatively free from gout until wine was introduced, and then the disease became more common. But though small beer, as shown from these observations, has little tendency to induce gout, strong ales and porter produce it readily. This has been noticed by Dr. Budd in the men employed in raising ballast from the bottom of the Thames during the ebb tide, who drink large quantities (sometimes two or three gallons) of porter daily. These men are mostly derived from the Irish peasantry, and have no hereditary tendency to gout; but this enormous consumption of beer induces the disease, so that many of them are affected with it. A few years' liberal indulgence in port or sherry will of itself, according to Dr.

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* Garrod on Gout and Rheumatic Gout. Third edition, 1876.

† As I am informed by Professor Horvath, of Kiev.

‡ Garrod, Op. cit. p. 219.

Garrod, produce gout even when no hereditary tendency exists. The light kinds of claret, hock, and moselle have little tendency to induce gout, and the population of France and the Rhine provinces are but little affected with it. The stronger kinds of these wines will both excite an attack of gout in persons already subject to the disease, and tend to produce it of themselves, as is seen in some of the larger cities of France and Germany. Champagne often excites an attack in gouty persons. This tendency is less when the champagne is dry than when it is fruity. Cider, when fully fermented and free from sugar (usually termed rough cider), has little power of inducing gout, but partially fermented (or sweet cider) may excite an attack of gout in persons predisposed to it.

The excessive use of alcoholic drinks has been said to cause dysentery, especially in tropical climates; but this does not seem to be perfectly established. The whole subject of the relation of alcohol to dysentery is well discussed in the "Medical and Surgical History of the American War,"* and the conclusion arrived at is that it is highly improbable that there is any direct connection between the use and abuse of ardent spirits and the causation of dysentery; and yet it is so well established that habitual intemperance impairs the general health of the drunkard, and that dysentery, when it occurs epidemically, is especially prone to seize upon those whose general health is impaired by any cause, that it is probable that drunkards may be somewhat more subject to attacks during the epidemic prevalence of the disease, and still more so, that as is often alleged, the disease is more fatal to patients of this class when attacked than to temperate persons.

In drunkards there is a great tendency to chronic catarrh of the respiratory passages; the back of the throat is often red and congested. This congestion extends down to the larynx, giving rise to hoarseness and expectoration of mucus. It very frequently extends also down the smaller bronchi, so that drunkards are rarely free from some form or other of chronic bronchitis. In them also there seems to be a marked tendency to acute inflammation of the lungs and pleura. When actually attacked by inflammation of the lungs, their chance of recovery is much less than that of a sober person, inasmuch as there is a greater tendency for a condition of œdema to appear in those parts of the lung not affected by the inflammation, and rapid death is the result.

The effect of alcohol upon longevity is most decidedly injurious.

In intemperate persons the mortality between twenty-one and thirty years of age is five times as great, and between thirty and forty years of age four times as great as that of the temperate. It becomes gradually less with advancing years, but at every age the abstainer has the advantage.

An Intemperate Person's chance of living is:	A Temperate Person's chance of living is:
At 20—15·6 years.	At 20—44·2 years.
„ 30—13·8 „	„ 30—36·5 „
„ 40—11·6 „	„ 40—28·8 „
„ 50—10·8 „	„ 50—21·25 „
60— 8·9 „	„ 60—14·285 „

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* Vol. I., part 2, p. 622.—Op. cit. 192.

If persons have once begun habits of intemperance, the average duration of life is among :—

Mechanics, working, and labouring men	18 years
Traders, dealers, and merchants	17 "
Professional men and gentlemen	15 "
Families	14 "

The mortality is greater in temperate persons who drink spirits than in those who drink beer, and the mortality is slightly greater when both spirits and beer are drunk than when either is drunk alone.

Another striking proof of the increase in longevity caused by total abstinence from alcohol, even as compared with its moderate use, is given by the statistics of the United Kingdom Temperance and General Provident Institution. This office consists of two sections—one of total abstainers, and another of moderate drinkers. Intemperate persons are of course excluded, as neither this nor any other insurance company will accept the lives, on any terms, of persons who are known to be intemperate. The two sections are exactly alike in every other respect, about twenty thousand lives being assured in the general section, and ten thousand in the temperance section. The quinquennial bonuses in the temperate section have been 17½ times greater than those in the general section, and the accompanying table will show how much less the mortality is in the abstinence than in the general section.

	Abstinence.	General.
Expected deaths	2,002	3,450
Actual	1,433	3,444
Actual number of deaths less than expected	569	6
Percentage of actual less than expected deaths	28·42 (nearly 28½)	·17 (nearly ⅙th).

From a comparison between benefit societies in which the members are not necessarily abstainers, such as Oddfellows and the Wesleyan Friendly Society, with others in which the members are abstainers, it appears that the average rate of sickness for the Colne Wesleyan Friendly Society is 10 days 19 hours, and the average death-rate is 13·9 per thousand; while, for the Rechabites, the average sickness is only 5 days 18 hours, and the average death-rate 9·9 per thousand, giving a gain in favour of total abstinence of 5 days 1 hour per member, and a less death-rate of 4 per thousand. The accompanying table shows comparative results at Bradford.

BRADFORD DISTRICT RECHABITES.			BRADFORD DISTRICT ODDFELLOWS.		
Average Sickness for 8 years : 1870-77.	Death-rate.	Payments.	Average Sickness for 8 years.	Death-rate.	Payments.
4 days 2 hours.	1 in 141.	5s. 9½d.	13 days 10 hours.	1 in 44.	13s. 1d.

The injury which a man does by indulgence in alcohol is not confined to himself, but descends in some degree to his offspring. The gout which he has acquired by indulgence he transmits to some extent to his descendants, and the children of drunkards are very liable to scrofula and to idiocy. But worst of all perhaps is the transmission of the craving for alcoholic liquors, by indulging which he has already injured his own constitution.

In the Fourteenth Report of the Inebriate Home at Fort Hamilton, near New York, Dr. Mason gives an analysis of 600 cases of drunkenness treated in the Home. From this it appears that insanity of parents was one of the predisposing causes to drunkenness in the offspring, but the principal predisposing cause was the hereditary transmission of the craving for drink. The proportion of drunken patients having intemperate progenitors was 46 per cent., the father having been a drunkard in 36 per cent. of the cases.*

According to Lancereaux,† of the morbid tendencies which the drunkard transmits to his offspring, some are purely functional and others organic.

The functional exhibit themselves in excessive sensibility, abnormal reflex excitability, and at a certain age an imperious craving for alcohol.

The organic consist of organic lesions, especially affecting the central nervous system.

Amongst the functional troubles are to be noted hysteria, convulsions, and mental deficiency.

The children of drunkards during the first few years of their lives are often precocious; but if they survive the convulsions or tubercular meningitis which frequently carry them off, they soon manifest an arrested development of intelligence, so that when at school they gradually lose the high position they had acquired, and sink lower and lower in their classes. Those who preserve their intellectual faculties are often attacked again by epileptic convulsions at the age of puberty. They generally lack mental equilibrium, and are restless and unsettled. They lack application, their temper is uncertain, and if they have any aptitude for literature or art, it is never of a high order.

The craving for alcoholic liquors which the drunkard transmits to his offspring manifests itself at varying ages. It generally appears when some great physiological change is occurring, as at puberty, and sometimes later during an attack of disease; in females during pregnancy, or at the menopanse. According to Dr. Mason, the inebriate tendency manifested itself in five-sixths of the cases treated in the Fort Hamilton Home between the ages of 15 and 35, and in the larger proportion between 15 and 25.

Sometimes, says Lancereaux,‡ youths begin to drink as soon as they leave college, and henceforward manifest a special craving for alcohol, which cannot be the effect of example, as they have been separated from their parents, and must, therefore, be hereditary. It is a mistake to attribute alcoholic tendencies in the children of drunkards to the example shown them, for those who have been removed from the care of their parents are no more free from the tendency than those who have lived with them. Besides, it is not only the children of people who get drunk that become drunkards, but the children of those who are addicted to chronic drinking without ever getting drunk. This unhappy tendency is sometimes continuous and sometimes intermittent, and frequently co-exists with vicious tendencies which render the unhappy heir to it an idle vagabond, incapable of living in society.

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* Reprint from the *Quarterly Journal of Inebriety*, April, 1881, p. 13; *vide* also *British Medical Journal*, Oct. 14, 1882, p. 751.

† Lancereaux: "De l'Alcoolisme," Paris, 1878, p. 27.

‡ Lancereaux, Op. cit. p. 27.

The morbid changes which occur in cases of hereditary alcoholic tendencies consist in inflammatory lesions of the nerve centres, which vary according to the age at which they occur in the fœtus, the child, or adult. During the fœtal condition, the changes are those of arrested development. The most complete is that where the brain is almost entirely absent, as in an encephalous infant, which is born without any brain. Another is that in which atrophy of the brain occurring during fœtal life or early childhood is partial instead of being complete, and affects only one-half of the organ. Such cases are generally accompanied by a deformity of the head, by epilepsy, and by hemiplegia with atrophy of the paralysed limbs. Sometimes the development of the whole brain is partially, instead of being completely, arrested, and the head is then very small; the individual is idiotic and sometimes paralysed in the lower extremities also. Out of 83 epileptic children or youths examined by M. Martin, 60 were the children of parents given to drink; and in 23 drunkenness was not ascertained. In 60 families to which the patients of the first series belonged the number of children had been 301; but out of those, 132 were dead at the time the observations were made. Out of the 169 surviving, there were 60 epileptics, 48 had had convulsions in early life, and only 64 could be considered as healthy. The 23 cases in the second series belonged to 23 families having 106 children, of which 27 were dead. Of the 79 surviving, 23 were epileptic, 10 had convulsions in early life, and 46 appeared healthy; a great number of these children also were paralytic and badly made. Excess in alcoholic liquors may be reckoned as one of the causes of infantile paralysis, but it is to epilepsy that it specially gives rise.

M. Lancereaux concludes his observations on the effect of alcohol on the progeny of the drunkard by saying that alcoholic liquors, such as are now consumed, pervert the most important and noble faculties of the man who abuses them; they disturb his nutrition; they make him old before his time; nay, more, they affect his progeny, whom they change and often kill. It is fortunate for mankind that, while the descendants of the good continue to enjoy the advantage derived from their forefathers for centuries, "the sins of the fathers are visited upon the children" only "to the third or fourth generation." The unhappy tendencies of the father are transmitted to the children, but a stop is put to the wide degeneration of the race which might otherwise occur by the fact that alcoholism tends to lessen reproduction as well as to increase mortality. Sterility may affect those who have acquired intemperate habits as well as the descendants of such persons, and the children, when born, being very liable to disease, the family is likely to die out.

In order to understand fully the influence of alcohol upon health, however, we must consider not only its direct influence upon the body and the mind of the drunkards and their offspring but we must take into consideration the effect it has upon their circumstances. A disproportionate part of their earnings being spent in drink, they are unable to afford for themselves and their families such good food, clothing, and lodging as they might otherwise have. At a certain stage of degradation, the drunkard may be still alive to all his own requirements while regardless of those of his family, and may leave them to be hungry and cold, while he is warm and comfortable at the public-house. But as his drinking habits continue, and years advance, his power of earning is diminished; instead of working the whole week he works only a part of it, and his labour during that time becomes less and less valuable. A few years ago a master-tailor told me that he had sometimes great difficulty in getting orders completed in time, because some of his best men only worked for about half the week. They were paid on Saturday, they were drunk on Sunday and Monday, and ill on Tuesday, and only began to work on Wednesday. Nor is the work so good after a debauch of this sort, although its imperfections may not be so manifest in tailoring as in trades where the work is very delicate, as, for example, in grinding lenses for microscopes. In this process the glass used for making the lenses is fixed in a holder and pressed against a rapidly revolving disc. It requires to be held with the utmost steadiness, and gradually turned in such a manner that it shall be equally ground over the whole surface, as the least inequality greatly diminishes or completely destroys the value of the lens. The quality of the lens can only be ascertained after it has been fitted up so that a test object can be examined through it. A celebrated microscope maker in Paris, while showing me this process, informed me that the lenses made by workmen who were perfectly sober, but had been indulging in liquor the day before, were of greatly less value than those made by them at other times; and where men were at all addicted to intoxication, it did not pay to keep them, as the loss of time in examining the lenses was so great.

As years pass, intemperate workmen become more idle and less able to labour, so that unless they are carried off by disease, they find their way into the workhouse.

There can be no doubt whatever that drinking is a great cause of pauperism, both in the drunkard himself and those dependent upon him. In the "Report by the Committee on Intemperance for the Lower House of Convocation of the Province of Canterbury," the testimony of governors and chaplains of workhouses was to the effect that between 70 and 80 per cent. of the inmates of workhouses became paupers through drink. But the amount of pauperism does not exactly coincide with the amount of drunkenness. By a comparison of the curves given on the table, Fig. 1, it appears that in those years when an increased amount was spent in alcohol there is rather a diminution in the number of paupers; and this, after all, is what we might expect. For an expenditure in alcohol usually means an increased amount of money to spend, and the same prosperity which fills the public-houses partially empties the workhouses. The increase of pauperism due to drunkenness does not occur at the time when the greatest amount of money is spent in drinking, but some years afterwards. If we compare the curves in the table, we shall see that there is a rise in the curve for alcoholic expenditure in the years 1861 and 1866, and a rise in the curve for pauper expenditure in 1863, 1869, and 1872. In 1876, when the expenditure for alcohol is highest, the curve of pauperism is lowest; and then, as the expenditure on drinking diminishes, the expenditure on pauperism increases. Bad years, which give the tippler less money to spend in drink, press hardly on the drunkards, who are readily broken down, and drive them and those dependent upon them to the parish for relief.

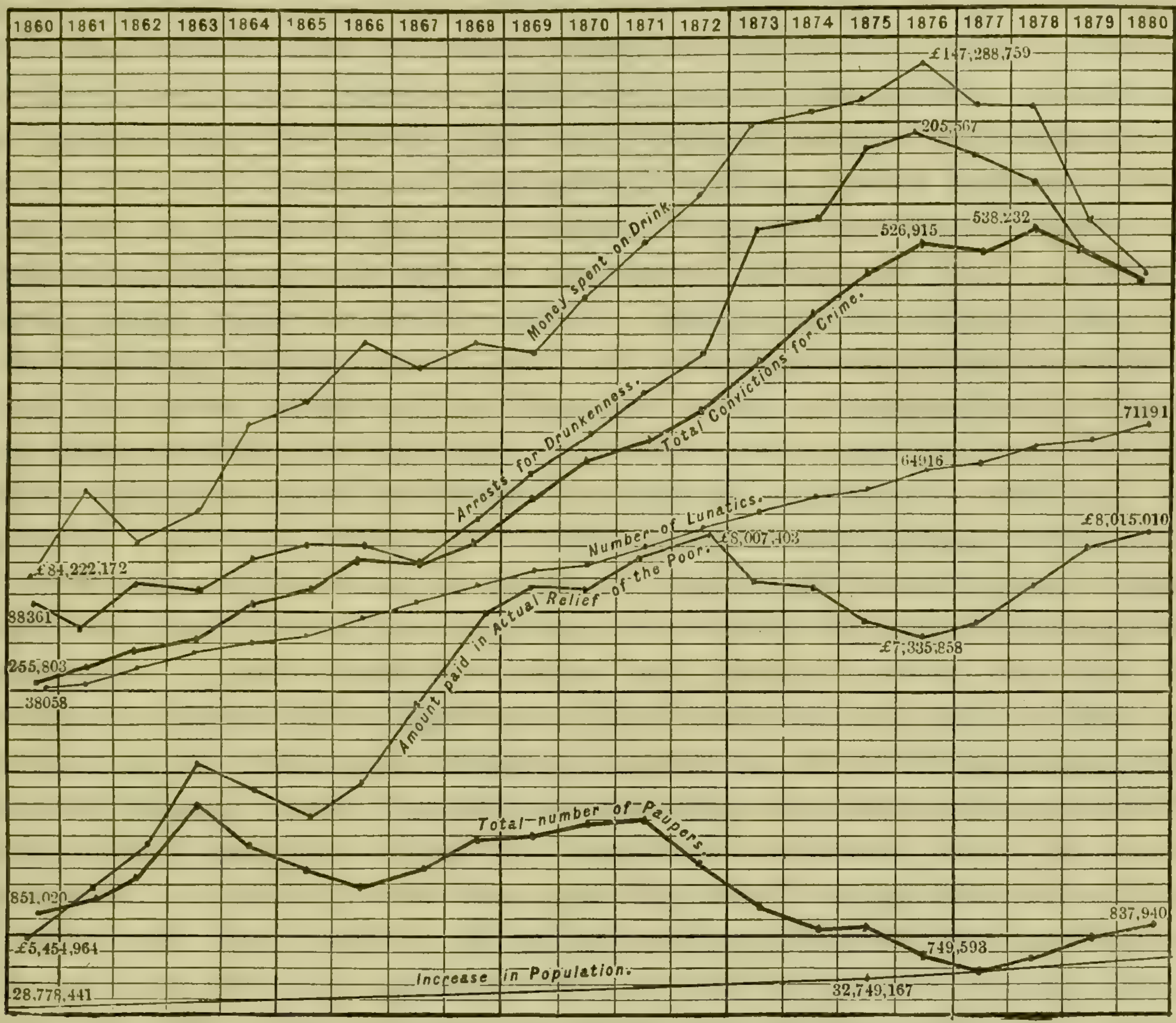

Fig. 1.—Curves representing the Increase in the Amount of Money spent on Drink, Number of Arrests for Drunkenness, Total Convictions for Crime, Number of Lunatics, Amount Paid for Relief of Poor, Number of Paupers, and Population from 1860—1880.

In this figure a different numerical value is given to the vertical divisions in each curve, each division roughly representing 1-20th of the number with which each series begins. In the curve of population, the value of each division is 1,500,000; paupers, 50,000; money paid in relief, £100,000; lunatics, 2,000; total convictions for crime, 10,000; arrests for drunkenness, 5,000; money spent on drink, £200,000.

Of the relations between crimes and drink it is unnecessary to speak; the accompanying table brings it out more fully than any words could do. From it we see that the curve which indicates the apprehensions for crime of all sorts follows the curve of alcoholic expenditure even more closely than the curve of apprehensions for drunkenness.

From the Thirty-fourth Report of the Commissioners in Lunacy to the Lord Chancellor, ordered by the House of Commons to be printed 2nd August, 1880, it appears that lunacy has been on the increase during the past ten years, and this in greater proportion than the increase in the population.

That intemperance is a cause of lunacy is generally admitted, but the exact relationship between the two is not altogether decided. Some are inclined to regard lunacy, or at least a tendency to it, as being the primary mischief, and the habits of intoxication as simply an outcome of this tendency. Others again regard intemperance as the cause of lunacy, while they acknowledge that intemperance alone may not produce it in cases where there is no hereditary disposition, or where the action of alcohol is not greatly aided by other causes, such as severe mental shock. There can be no doubt that a person having an unstable and weak organisation is more likely to fall into habits of intoxication than a man of a stronger nature, as has already been mentioned, and such an organisation, while it may lead to great achievements in literature or art, is, from its instability, liable to various aberrations, so that the proverb has arisen that genius and madness are near akin. These aberrations may make themselves manifest in an individual who has at one time shown signs of genius, or at least of talent, or may appear as undoubted madness in another member of the same family. To such persons the attractions of alcohol are usually great, and its effects upon them disastrous. It may, and often does, supply the force needed to overturn their mental balance and produce well-marked insanity. The insanity in such a case, while evidently due to drink as an exciting cause, might with almost equal fairness be put down to the tendencies of the individual, and probably would be so put down if insanity had appeared without drink in other members of the family. But, on the other hand, according to Lancereaux, a tendency to mental instability is one of the unlucky qualities transmitted by a drunkard to his children; so that while the drunkard himself may escape insanity, the alcohol which he has taken produces a tendency to it in his offspring. Not only may it produce the tendency to insanity, it may and does produce in a large number of cases idiotcy and imbecility in the drunkard's children; and thus alcohol may be looked upon as a direct, as well as a predisposing, cause of insanity. In the Report to Convocation, one superintendent of a lunatic asylum estimated that the proportion in which alcohol acted as a direct and sole exciting cause of lunacy was in one-sixth of the cases, and as an aid to other causes in a much larger proportion. Another considered that directly and indirectly the proportion due to intemperance was about 50 per cent. The proportion of cases admitted into Bethlehem Hospital during 1875–6 in which lunacy was due to intemperance was 6·25 per cent. in males, 5·61 in females; and of 511 cases admitted into the West Riding Asylum, Yorkshire, in one year, 11·35 per cent. were due to alcohol, 1·56 were due to alcohol complicated with habitual tendency to insanity, 2·93 per cent. were caused by excess of alcohol combined with other adverse physical conditions, and 1·95 per cent. were due to alcoholic excess combined with mental causes—a total of 17·79 per cent. of alcoholic cases on the admissions. The total percentage on the male admissions was 31·20, and that on the female admissions only 4·98.

Dr. Bucknill shows by those statistics that the common statements that drink causes from 50 to 80 per cent. of all the mental diseases in this country are considerably overdrawn; yet the conclusion he comes to is, that "drunkenness is the greatest remaining curse of this age and country," and he believes "intemperance in drink to be by far the most potent of all removable causes of mental disease."*

The curve (Fig. 1) shows that, while there is a distinct relationship between the curves for alcoholic expenditure, amount of crime, and amount of pauperism, no such distinct relation exists between alcoholic expenditure and amount of lunacy. Instead of following the curve of alcoholic expenditure, the curve of lunacy forms rather a slightly undulating line more nearly corresponding to the rise in population; but the rise is much more rapid than that of population, the increase in lunacy from 1865 to 1875 being 67 per cent., while that of the population was only 13 per cent.; and the increase of drunkenness in the same time was 130 per cent.†

Before quitting this subject of alcohol, it may perhaps be advisable to give a short *résumé* of its action and place :—

When drunk, it increases the secretion and movements of the stomach and intestines, and thus, in moderate quantity, may aid digestion; but, in some persons, beer and wine, even in moderation, instead of aiding, may retard digestion; and when gastric catarrh is present may interfere with it most seriously, so that, in such cases, alcohol in every form should be carefully avoided.

In acute diseases, it seems to aid digestion rather than to interfere with it, and is, therefore, useful along with food in acute diseases—such as fevers, in convalescence from acute diseases, and in chronic wasting diseases—such as consumption.

It may also be taken in moderation, that is to say, in a quantity not exceeding at the utmost two ounces of absolute alcohol in twenty-four hours, either as a luxury by healthy people, or as a medicine by those whose digestion is below par on account of debility from various causes.

Young and healthy people do not require it, and are better without it.

Its action on the circulation is to increase the force of the beats of the heart, and the rapidity of the circulation. It is, therefore, useful in conditions of great weakness, where failure of the circulation threatens a fatal issue.

It is uncertain whether or not it has any stimulant action on the nerve centres apart from its reflex effect through the nerves of the mouth and stomach, and its stimulant action upon the circulation. Any stimulant action which it may have upon the nerve centres apart from these is slight and transitory, if it exists at all; and its chief action is one of paralysis. The various parts of the nerve centres are paralysed in the order of their development, the highest and latest developed being the first to suffer. The usual order is as follows : first judgment and self-restraint disappear; then the power of perceiving the relations of external circumstances to the organism is lost, and the man becomes foolhardy, ridiculous, stupid, quarrelsome, or maudlin. The cerebellum follows next, and the power of co-ordination is lost; then the spinal-cord; and last of all the medulla oblongata and heart. Alcohol reduces a man first to the condition of a child, and then to that of a beast.

By stimulating the circulation, and at the same time producing a childish joyousness, alcohol gives pleasure, and this pleasure, when indulged very moderately, may be productive of no bad effects. It is, however, in those people in whom the pleasure is greatest that the danger of being led into excess is also greatest. Individuals in whom the hereditary craving for alcohol exists, or in whom the hereditary tendency to insanity renders the development of such a craving probable, ought to become total abstainers. It would be indeed advisable that no one, even though free from hereditary tendency to drunkenness, should touch either wine, spirits, or beer before the age of twenty-one.

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* "Habitual Drunkenness and Insane Drunkards," John Horace Bucknill, M.A., F.R.C.P., pp. 85-8.

† Third Report on Intemperance before the Select Committee of the House of Commons, 1877, p. 301.

The different forms of alcohol, spirits, wines, and beers have somewhat different actions, partly on account of their different strength, and partly from the additional ingredients which wines and beers contain. As a rule, the most harm is done by spirits, and least by small beer and weak wines, such as those drunk by the peasantry abroad. Strong ales and strong wines are intermediate between spirits and the weaker wines and beers, and may, like spirits, be productive of considerable harm. The drunkenness caused by spirits is more likely to be furious; that by wine, gay; and that by beer, stupid.

Alcohol does most harm when taken upon an empty stomach, and least when taken with food. Much exercise in the open air lessens its injurious effect. Excess in alcohol diminishes the strength, both physical and moral, of the individual, and tends to shorten his life, to induce insanity, to lead him into poverty and crime; and the mischief he has done to himself he transmits to his children. Besides the privations and temptations to which the children of the drunkard are exposed, they inherit a weakened body, a tendency to convulsions, to idiotcy, and to insanity, or at least an unsettled mental equilibrium, which renders them useless members of society, flighty, unsteady, and untrustworthy. In addition, they inherit the craving for drink which usually develops itself between the ages of fifteen and twenty-five.

Ether.

Another stimulant, which is sometimes used in place of alcohol, is ether. This is generally employed in manufacturing towns, and sometimes has been used by the population after they have taken the pledge to abstain from alcohol. The effects of ether are in many respects similar to those of alcohol. It differs from it, however, in some respects: it does not cause coagulation of the albumen contained in the blood, nor does it produce the same burning taste in the mouth, or feeling in the stomach. It is a much more powerful stimulant of the digestive secretions and of the movements of the stomach and intestines than alcohol, and might thus, perhaps, be employed with much advantage as a substitute for alcohol in cases of dyspepsia. Its effect on the nervous system resembles that of alcohol, but it is produced more rapidly, and passes off more quickly.

Opium.

Another stimulant, or rather narcotic, which is extensively used is opium. This is the dried juice obtained from poppy-heads. Most of it is grown in Asia-Minor and India, though some is obtained also from Persia and Egypt. When the poppies are still green, but nearly full-grown, they contain a thick white juice. At this time men are sent to the poppy-fields, who make a number of deep scratches into the poppy-head, and from each scratch the juice exudes. In about twenty-four hours after, it is scraped off and collected. It is allowed to become dry and thick, and is then made up into lumps. It occurs in several forms, according to the country from which it is brought; some of that grown in Asia-Minor and brought to this country, *viâ* Constantinople, occurs in small masses about a quarter of or half a pound in weight, and wrapped in a poppy leaf; while that brought from Smyrna is brought in masses from a quarter of a pound to two pounds in weight, and covered with dock-seeds. Some of the East Indian opium comes in flat square cakes, as the Malwah, or garden Patna opium; but most of it is in round balls, like cannon-shot, or rather shell, about six inches in diameter, and about four pounds in weight. The inside of this consists of a soft, dark mass of opium, with a thick case of poppy leaves, so that in section it somewhat resembles a shell, the dark opium in the centre corresponding to the gunpowder.

Opium contains several active principles. As some of these are chemically related to ammonia, and have like it an alkaline action, they are called alkaloids. But they differ from ammonia in being much more complex in their constitution, and containing a quantity of carbon. The chief alkaloids in opium are morphia, codeia, and thebaia. These are combined with a vegetable acid called meconic acid. The alkaloids contained in opium have different actions; but they may be arranged to a certain extent in a graduated series. At one end of the series stands morphia, which, when given to animals, has the power of producing sleep, but has no marked action in causing convulsions, excepting in frogs. At the other end stands thebaia, which causes convulsions very much like strychnia, and has almost no power of producing sleep. The other alkaloids may be arranged intermediately between these two, all of them possessing a mixture of narcotic and convulsive powers, but in different proportions.

Unlike alcohol, opium has no irritant local action, and thus the effects which alcohol produces reflexly are entirely wanting in its case. The effect it produces is through its action on the circulation and nerve centres after it has been absorbed. It has been questioned whether it has any local action at all; but I think it is difficult to deny that such local action does really exist, for when applied to a painful part it lessens the pain even before it has produced any effect on the body generally. It has also been found that when locally applied to the foot of a frog it lessens the sensibility of the skin. It appears to produce this effect by blunting the sensibility of the sensory nerves of the part to which it is applied. In the mouth it has a somewhat bitter peculiar taste. When put into the cavity of a decayed tooth, it frequently lessens the pain. A good mixture for this purpose is laudanum, with a little bicarbonate of soda, placed upon a pledget of wool.* When swallowed it lessens the secretion and movements both of the stomach and intestines; at the same time it diminishes their sensibility, and will remove the sensation of hunger. It is useful in lessening the pain of colic, or of abdominal inflammation. From the local blunting effect which it exerts on the sensory nerves of the stomach and intestines it tends to prevent vomiting, and to arrest diarrhœa. As its chief effects are produced by its action on the nerve centres, after it has been conveyed to them by the blood, it is evident that its power will depend very much on the rapidity with which it is absorbed. Thus it has happened that during the cold stage of cholera, when absorption from the stomach had almost ceased, large quantities of opium have been given without apparently the least effect; but after the patients began to recover, and absorption again commenced, they died, poisoned by the opium, which had till then remained unabsorbed. It is by this want of absorption also that we may explain the curious instances which we sometimes find of delayed action after opium has been taken. I was once asked at eight o'clock at night to see a lady who was poisoned by opium. She had been suffering from toothache, and at eight o'clock on the previous night she took a dose of laudanum, which appeared to have no effect. An hour or two afterwards she took another dose, which was also apparently without effect, and again a third, which also failed to relieve the pain, and she remained awake all night. About eight o'clock in the morning, however, she fell asleep, slept all day, and the sleep became gradually deeper and deeper, until at eight o'clock on the second night she was in a state of coma. By the use of proper measures she was gradually brought round, and in about four hours appeared out of danger. Here, in all probability, the laudanum had simply remained unabsorbed in the stomach for several hours, giving no relief, and indeed producing no effect until after absorption had begun, when the large amount that had been taken produced symptoms of poisoning.

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* Duckworth : "Practitioner," Vol. XIV., p. 260.

Another remarkable instance is that of a gentleman of my acquaintance who suffered for awhile from great pain, and had been obliged to take opium for its relief regularly during a period of three months. At first a small dose was sufficient to relieve the pain, and it acted in about a quarter of an hour; but as he became more and more habituated to the drug, he not only required a larger dose, but was obliged to take it a long time beforehand. So much was this the case that towards the end of the period, when he had begun to discontinue the drug, he found that if he wished for a good night's rest he had to take the opium not less than twenty-four hours before.

While absorption of opium is going on from the stomach and intestines, excretion is also taking place by the kidneys. The quantity of opium circulating in the blood at any one time, therefore, amounts simply to the difference between what has been absorbed and what has been excreted. It is evident that if absorption goes on slowly, and excretion goes on rapidly, there may never be enough opium in the blood to produce any perceptible effect upon the nerve centres. Probably this is the explanation of these cases of idiosyncrasy in which persons totally unaccustomed to take opium have been able to swallow without the least effect a dose of opium which would usually prove certainly fatal. A case of this sort is related by Sir Robert Christison, where a gentleman of his acquaintance, not accustomed to the use of opium, took 450 drops of the best laudanum without any other effect than some headache and constipation; and, singularly enough, his son at the age of six years took sixty minims of solution of hydrochlorate of morphia without any apparent effect at all.

It is equally evident that where either absorption is quick or excretion slow, the effect of opium will be disproportionately great. This appears to be the case in persons who suffer from some forms of kidney disease, in whom morphia is apt to produce dangerous results. In children, also, opium produces a disproportionately great effect; so that a single drop of laudanum has been known to kill an infant. This might be partly due to rapid absorption and slow excretion; but this is by no means altogether the case. After its absorption its action will be modified by the condition of the nerve centres themselves, and in the child the mass of the brain is very large in proportion to the body, although it is yet undeveloped in structure.

Opium, when taken in small doses, has but little effect upon the circulation, and in this respect also is unlike alcohol. In moderately large doses it somewhat quickens the heart, and somewhat lowers the tension in the vessels. Like alcohol, it appears to lessen the disturbing influence of surrounding conditions upon the organism. First of all it seems to cause a soothing sensation, and any pain or irritation which may be present usually is diminished or disappears. According to Sir Robert Christison, the nervous excitement it produces may be directed into different channels by the will of the individual. Some years ago a railway accident took place on a dark night, and the cause of it was rather peculiar. For some reason or another, the engine-driver had been compelled to stop the engine and reverse its action, and on again starting, he turned on steam as usual, but forgot to alter the movement of the engine to a forward one. The consequence was that, instead of going forward, the engine and train ran backwards. From the darkness of the night the engine-driver did not see the direction of the movement, and the engine and train ran backwards instead of forwards for several miles, so that a collision was the consequence. Here the steam had been turned on as usual, but the mechanism upon which it acted had been altered. A somewhat similar condition appears to occur in the human brain under the influence of opium. Thus if the person taking opium yields himself up to its somnolent influence, he falls into a quiet sleep; this generally continues for six or eight hours, and is followed for some hours longer by listlessness, giddiness, and languor; or sometimes also by sickness, loss of appetite, and headache. If he desires rather to enjoy the pleasures of reverie, he may sit down and have a series of pleasant day-dreams for a considerable time; or if he desire to work, his faculties become clear, his ideas brilliant, precise, and uncontrolled, his power of application more intense, his conversation and energies improved, and his muscular movements facilitated. After some hours a stage of drowsiness ensues, as after the hypnotic operation of the drug.

"During the prolonged excitement of the nervous system," says Sir Robert Christison, "it seems probable that the particular manifestations of the excitement are directed partly by constitutional peculiarities, but occasionally by an effort of the will, and thus one man becomes a lively, conversable member of his social circle; another applies with energy to the labour of literary composition;

another, in placid indifference to everything around, indulges in a trip to the realms of fancy; and another, turning his mind to the expression of what is passing within him, performs a series of extravagant, irregularly connected acts, transcending in some measure the phenomena of intoxication. These singular varieties in the action of small doses sometimes originate in constitutional peculiarities; but this is probably not so often their real cause as commonly thought. They may be sometimes satisfactorily referred to the effect of an original impulse of volition. I have known most of them to be produced under different circumstances in the same individual." *

De Quincey thus describes the effect which opium produced upon him when he first took it for the relief of pain :—

"But I took it, and in an hour, O heavens! what a revulsion! what an upheaving, from its lowest depths, of the inner spirit! What an apocalypse of the world within me! That my pains had vanished was now a trifle in my eyes. This *negative* effect was swallowed up in the immensity of those positive effects which had opened before me—in the abyss of divine enjoyment thus suddenly revealed. Here was a panacea—a *φάρμακον νηπενθές*—for all human woes. Here was the secret of happiness about which philosophers had disputed for so many ages at once discovered! Happiness might now be bought for a penny, and carried in the waistcoat-pocket; portable ecstasies might be had corked up in a pint-bottle; and peace of mind could be sent down in gallons by the mail-coach."

The after effects, even of a small dose of opium, when the primary sleep or excitement has passed away, are nausea, headache, and depression. These are best relieved by lemon-juice and strong coffee. They also disappear under the influence of a renewed dose of the drug; but when opium is taken continuously it gradually loses its power, and the dose requires to be increased. The quantity which opium eaters will take is sometimes enormous. De Quincey, the English opium eater, at last took nine ounces of laudanum, which is equal to 333 grains of solid opium, daily. Mr. W. E. Image, of Bury St. Edmund's, observed two cases in which no less than sixteen ounces of laudanum per diem were taken.

As the habit becomes confirmed, the excitement diminishes, and the miserable after-effects become more marked. So much is this the case that after a time the habit is continued rather for the purpose of avoiding extreme misery than for obtaining positive pleasure. So long as opium is taken only in moderation it seems, like alcohol, to be perfectly well borne, and to produce no injurious effects, even when continued for years together; but when taken in excess it destroys the digestion, greatly impairs the nutrition, and ruins the nervous system. Like alcohol it lessens or destroys the power of volition, so that the unhappy victim becomes a complete slave to the habit, and he has no power to throw off its yoke. The resemblance between this condition will be readily seen by comparing the account given by Coleridge† of his inability to shake off the habit of opium eating with the account given by Mr. J. Vine Hall of his inability to throw off the habit of alcoholic indulgence.

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* Christison: "Dispensatory," p. 682.

† Cottle: "Early Recollections," Vol. II., p. 185.

Yet notwithstanding the apparent powerlessness of both Coleridge and Hall to throw off the ensnaring toils of opium and alcohol, they both of them after many struggles succeeded.

Another method of taking opium is to smoke it instead of swallowing it: this is the plan generally adopted in China. It seems curious that opium while smoked should produce such effects, because the active ingredients which it contains are not volatile. The subject has not yet been thoroughly investigated, but it seems not improbable that the substances actually taken into the body are not those which are contained in the opium, but others nearly allied to them and having a similar action. These are produced from the opium by the heat of the pipe which is employed, in the same way as pyridine and other substances are produced from tobacco during smoking.

In moderation opium smoking, like opium eating and alcohol, does not seem to interfere with, but rather to assist labour, mental and bodily. In the evidence given by Mr. Cooper before the Committee on Indian Finance in 1871, he states that his chair coolies carried him 20 miles a day, and were strong and enduring as long as they got their daily supply of opium, but they became wretchedly weak and miserable after a single day's abstinence, when they would lie down with water streaming from their eyes, listless, disinclined to eat, and unable to sleep.

Mr. T. Evans informs me that the Lascar sailors in the Peninsular and Oriental steamers work hard and steadily while they have their daily supply of opium, but should the voyage last longer than they anticipated, and their supply of opium run short, they become listless, languid, and miserable, and unable to work; while in some a condition of frenzy occurs.

In moderation opium does not seem to impair the intellectual powers, and Chinese merchants, who are certainly sharp and clear-headed enough in their business, will smoke opium regularly.

It is a question difficult to solve whether or not opium is worse than alcohol. It certainly does not seem to lead to so much crime; its effect when taken in moderation appears certainly to be no more injurious to the system. The chief disadvantage seems to be that the taste for opium gains, if possible, a firmer hold upon its victim than the taste for alcohol, and that there is a greater tendency to immoderate indulgence on account of the ease with which the system becomes accustomed to the drug and the consequent necessity for an increase in the dose.

The effect of morphia is much the same as that of opium, either when taken internally or when taken by injection under the skin. According to Dr. Levenstein, who has particularly studied this subject, after its use there is a condition of mental excitement. The temperature is altered, depressed persons become lively, to the fainting it imparts strength, to the weakly it restores energy, the taciturn become eloquent, shy persons lose their bashfulness, and the consciousness of power and ability is greatly increased. But after these effects have passed off, reaction sets in, and a condition of deep despondency ensues. For the relief of this depression the patient either takes a fresh dose of morphia, or has recourse to alcohol. The evil results arising from the abuse of morphia generally begin to show themselves in from four to six months, but sometimes only after some years;

this depends upon the individual constitution, and not upon the dose. Just as in the case of opium, many persons feel quite well while using morphia, but after a time the nervous system and the nutrition become affected, the skin becomes less elastic, the face pale and the body thin, the perspiration excessive, the eyes are listless, the pupils generally contracted, and vision frequently impaired. There is dryness of the mouth, thirst, loss of appetite, nausea and vomiting, the bowels are generally confined, the pulse is usually very small, there is dyspnœa and palpitation, loss of sleep, irritability of temper, hallucinations, disturbances of sensation, as hyperæsthesia and anæsthesia, trembling of the hands, and depressed reflex action. In some cases albuminuria is present, and the urine generally reduces an alkaline solution of sulphate of copper, but does not precipitate it; it also generally rotates polarised light to the left.*

The use of morphia, however, is not incompatible with a high degree of intellectual power, for Dr. Levenstein mentions that he knows a number of persons who suffer greatly from the craving for morphia, and who have yet risen to and still hold their place in the foremost ranks of science and art. Authorities in military matters, artists, physicians, surgeons, bearing names of the highest reputation, are subject to this craving, without the least detriment to their capacities; and some also may retain the highest admiration of their fellows to the very last.

The progress of the craving is generally slow and fluctuating; some are able to take large doses for many years without any symptoms, whilst small quantities will bring on the most severe symptoms in others in a few months. There are frequent intermissions, during which the morbid symptoms begin to disappear, notwithstanding that the use of morphia is continued, though usually in smaller doses. The improvement usually lasts, however, only for a few months, when the dose is again increased, and the symptoms reappear and become aggravated. If no cure is effected, the ultimate result is prostration, emaciation, and death. When people have once suffered from the craving there is always danger of a relapse, and this is still greater if there is a craving for alcohol as well. Once cured, they must never have morphia again, as a single injection administered to such a person is sufficient to vanquish the power of resistance against the craving which has been successfully kept up for months together.

In treating such persons, according to Dr. Levenstein, it is best to deprive them at once and completely of morphia, instead of gradually withdrawing it; and to ensure success the patient should be kept entirely apart under the constant care of nurses, and in a room from which everything by which suicide can be committed has been carefully removed. The strength must be kept up by careful feeding, although for the first few days fluid food only is to be given, and wine or alcohol according as it is necessary. Headache is relieved by cold, pains in other parts of the body by poultices, nausea by ice, sleeplessness by warm baths. When dangerous collapse comes on it may be necessary to give half a grain of morphia subcutaneously. After the morphia has been completely withdrawn for three or four weeks, the patient may be sent to a mountainous district, to the south of Europe, or to a cold-water cure, according to his strength and the season of the year.

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* "Morbid Craving for Morphia," by Edward Levenstein.

Chloral.

Another narcotic which is now very much used is chloral. This substance was first introduced by Dr. Oscar Liebreich. It is split up on the addition of alkalies into chloroform and formic acid, and Liebreich supposed that when absorbed into the blood, it would become decomposed in this way and slowly liberate chloroform; he thus expected to obtain anæsthesia lasting over a considerable length of time. His expectations were to some extent realised, although it appears that chloral is not decomposed in the blood as he thought it would be. It appears to act in virtue of its own peculiar properties, and causes in man and animals sleep, which is at first quite natural, and from which a person can be readily awakened; in larger dose the sleep becomes deeper, and the person is awakened with great difficulty; in larger doses still it produces complete anæsthesia, and a sleep from which a person cannot be aroused. It is frequently used as an anæsthetic for animals, but it cannot be employed for this purpose in man without great risk. The sleep caused by chloral differs considerably from that of opium in several respects. Chloral does not appear to have the same power as opium to relieve pain, although it will do so when given in large doses; but the sleep that it produces is more natural, and it is not followed by the same disagreeable after-effects as opium, the person who is taking it awaking bright and clear-headed, just as from natural sleep, instead of suffering from headache, loss of appetite, nausea, and sickness, as after opium.

On this account chloral has been of late years very widely used by persons suffering from sleeplessness and nervous irritability, and is taken by many people not by the advice of a medical man, but of their own accord. They often continue to do this for a considerable length of time, and think that because there is no immediate disagreeable result the use of the drug is free from danger of any sort. This is not the case, however, for chloral is exceedingly dangerous, both from its power of causing rapid death when taken in an overdose, and from its destructive effects on the nervous system when taken in small doses for a long time together. The symptoms it produces, when taken in an overdose, are deep sleep, passing into perfect unconsciousness, from which the person cannot be awakened: the breathing and pulse become weaker and weaker, and the patient dies.

Professor Stricker and I have found that the deadly effects of chloral can be to a great extent counteracted by means of heat. In cases of chloral poisoning, then, it is most important to keep the patient warm, as well as to employ the measures usual in the treatment of poisoning. The symptoms produced by chronic poisoning with chloral present several forms: some of these are connected with the skin, others with the mucous membranes, others with the respiration, others with the blood, and yet others with the nervous system.

In the skin, chloral produces a tendency to eruptions of various kinds; these take the form of simple diffused redness, or erythema, more particularly marked about the head and face. It may be constantly present, but in some persons it only occurs temporarily, and whenever anything is taken to stimulate the vascular system.

In such persons very small quantites of wine or beer produce a deep red colour on the face and neck, lasting for an hour or more; and sometimes the eruption extends over the whole body, and may last for a day or two. Instead of simple erythema a papular rash may appear, and sometimes a well-marked nettle-rash is produced.

A condition of the mucous membrane similar to that of the skin may occur as a consequence of the use of chloral: thus in some the conjunctiva becomes red and swollen, and the eyes run; in others there is sore throat and pain on swallowing. The respiration may become very seriously affected, the patient suffering from severe dyspnœa, with occasional cessation of breathing. At first this may simply be felt on going up-stairs, especially after meals; but when the drug is continued, it may increase to such an alarming extent as to threaten death.

The blood appears in some to undergo changes which give rise to symptoms resembling those of scurvy or even of blood poisoning; not only is the skin red, but in patches it becomes livid; the gums are spongy, the mouth and tongue blistered and ulcerated, and the breathing affected. To these symptoms succeed prostration, drowsiness, difficulty of breathing, and death. In some instances the occurrence of the red rash in the skin is accompanied by a high fever, with desquamation of the skin, watery discharge from the mucous membrane of the intestine and bronchi, and in the formation of abscesses in various parts of the body: a condition which strongly resembles that of blood poisoning.

In other cases the nervous system seems to suffer most, and the mental qualities are diminished, and sometimes are so greatly affected as to render the person almost idiotic. The powers of sight in some are weakened, and the muscles of the throat are sometimes so much affected that it is almost impossible to swallow. Paralysis of the lower extremities, with diminished sensibility, has also been observed as a consequence of chloral. In others a condition almost exactly resembling delirium tremens has been said to occur when it was discontinued, after being used for a length of time.

INDIAN HEMP.

Indian hemp is a narcotic little used in this country, but employed to a considerable extent in the East. It consists of the flowering tops of the common hemp grown in India. This plant when grown in cold countries such as our own has little or no intoxicating power, but when grown in the warm districts of India, a resinous exudation is secreted by the leaves and flowering tops, and to this resin the intoxicating powers seem to be due.

Several preparations of it are employed, and it is known under different names. The flowering tops, gathered before the seeds become ripe and dry, are known by the names of *haschisch* and *gunjah*, the former being the Arabic, and the latter the Indian term. A coarse and cheap preparation, consisting of the larger leaves and capsules, is known by the name *bhang*, and is used by the poorer classes. The resin itself, rubbed off from the leaves, and with a small proportion of the leaf tissue remaining in it, is known by the name of *churrus*. This is often mixed with other substances to render it more pleasant to the senses, and to increase its power, such as otto of roses, musk, cantharides. The *churrus* is said to be collected in central India by a man clad entirely in leather, walking through and through the hemp fields, and then scrapping off from his clothing the resin which adheres to it as the tops of the plant brush against him during his peregrinations. Haschisch is usually said to produce most delicious dreams, which Dumas has described in the account of Monte Christo. The name of assassin is derived from haschisch, because the chief of the assassins was said to initiate each member into the mysteries of the society by intoxicating him with haschisch, and then conveying him into a garden, where he enjoyed all the sensual delights of the Mohammedan paradise. After a while he was again intoxicated and removed back to his ordinary conditions of life. Confident that his chief possessed the power of conveying him again to paradise at his death, he was willing to run any risk, or endure any suffering, in the execution of his orders. Under the influence of haschisch, the Malays seem to become insane, and run a "muck," as it is termed, rushing madly along and stabbing every one who comes in their way. It generally seems to excite a tendency to laughter, but most observers belonging to Western nations have found its effects rather disagreeable than pleasant. The flow of ideas seems to be very greatly quickened, while the individual loses all power of directing them. There is a feeling of great prolongation of time, so that a minute seems hours, and occasionally there is a curious condition of double consciousness. In some persons the power of motion is a good deal lessened, and occasionally convulsions have been noticed. Catalepsy is also said to occur among the Hindoos.

Haschisch differs from opium in leaving very little after-effect, the person usually awaking from the heavy sleep into which he usually falls, after the delirium has lasted for a while, without any nausea or sickness as after opium, but rather with a good appetite.

TOBACCO.

Tobacco is another narcotic in most extensive use. The tobacco plant, *Nicotiana tabacum*, belongs to the natural order *Atropacea.* It contains an alkaloid called nicotine, or nicotia, combined with a vegetable acid. It differs from most other alkaloids in being liquid instead of crystalline, and in containing no oxygen, being composed of carbon, nitrogen, and hydrogen only. The pure alkaloid is a most intense poison. After a drop or two of the liquid has been taken, the person becomes almost immediately unconscious, with a wild look, and dies, with a deep sigh, in less than five minutes. When given to animals, a single drop will kill a cat or rabbit in two or three minutes, but usually causes convulsions which have not been noticed in man. Tobacco itself, when swallowed, will also cause death, as in the following case from the "Naval Medical Reports:"—

"A sailor boy had been frequently punished for chewing tobacco, and had often complained of debility, giddiness, and faintness, which were traced to the poisonous effects of this substance. On two occasions he had swallowed a piece to avoid detection. On the night of his death he went to his hammock, telling his messmates that he felt sick. About ten minutes afterwards the occupant of the next hammock heard him breath stertorously, and immediately tried to awaken him. He could not succeed, and when the surgeon came he was found to be moribund. The pupils were insensible to the influence of light, and the pulse, which was scarcely perceptible, in three minutes ceased to beat. On a post-mortem examination two small pieces of tobacco were found in the stomach."*

Poisoning also sometimes occurs from absorption through the skin, as appears from the following instance :—

"Dr. Namias relates an instance of a smuggler being poisoned by reason of his having covered his skin with tobacco leaves, with a view of defrauding the Revenue. The leaves, moistened by perspiration, produced all the effects of poisoning. The pulse was small and feeble; there was faintness, attended with cold sweats. The operation of the poison seemed to be principally on the heart."†

It has been found that the heart is the organ chiefly affected by tobacco. The effect is a peculiar one, for it first stimulates and then paralyses those fibres in the vagus nerve whose office is to regulate the beats of the heart and prevent it from going too quickly. These fibres are generally known as the inhibitory nerves. In consequence of this action, the heart's beats become very slow at first, and afterwards very rapid. Just at the time when these inhibitory nerves are beginning to lose their power, we may find alternate quick and slow beats of the heart. This condition may not only occur in animals poisoned by tobacco, but it may be observed in men. Some years ago I was resident physician in the Royal Infirmary at Edinburgh, and I had frequent opportunities for observing this condition. I have not seen it at all so frequently in other parts of the country, and I am inclined to think that it was due to the fact that a number of poor people living in the neighbourhood of the Infirmary were accustomed to use very coarse and strong tobacco in large quantities. The beats of the heart, instead of being regular, had a rhythm which reminded one of a restive horse, breaking off into a galop for a few yards, and then being suddenly pulled up, and then breaking off again. This condition was usually known in the Infirmary by the name of "smoker's heart." It disappears when the use of tobacco is left off entirely, but is apt to return when its use is again resumed. When once it is fairly established, also, it seems that a very small quantity of tobacco is sufficient to maintain this abnormal condition, so that it is not sufficient to diminish the quantity of tobacco used; complete abstinence must be enforced in order to effect a cure.

The chief ways of using tobacco are chewing, snuffing, or smoking. In chewing, the piece of tobacco is kept in the mouth, turned about, and masticated, the juice being expectorated. The chief effect of the tobacco thus employed is a local one, consisting in the stimulus which it produces on the sensory nerves of the mouth, and the reflex action which it exerts upon the salivary glands, and probably, also, on the circulation, not only to these glands but to the brain. Absorption from the mucous membrane of the mouth does not take place nearly so readily as from the stomach, and thus the amount of nicotine actually absorbed will be not only small in itself, but its introduction into the body will be slow, so that more time is allowed for its elimination. We have already mentioned that active circulation is generally associated with pleasure, and that the various organs of the body during functional activity have the circulation increased. This has been very clearly observed in the case of the salivary glands, a stimulus applied to the tongue or mucous membrane of the mouth producing reflexly in them, not only a secretion of saliva, but such an accelerated flow of blood through them that when the vein which returns the blood from them is wounded the blood gushes out from it in jets, as if from an artery, instead of trickling slowly, drop by drop, as it would do when the gland is inactive. When the brain is active, the circulation in it also is greatly increased, and such an increase in the circulation will be produced by an irritation of the nerves of special sense. By observations made directly upon the brain, it has been found that an unexpected sound, for example, increases the amount of blood in the organ, and usually this is accompanied by a contraction of the vessels in other parts of the body; so that the increase in the quantity of blood going to the brain is compensated by a diminution in the quantity going to other parts of the body. The contraction of the vessels in other parts of the body also tends actually to drive blood into the brain. In the opinion of Professor Mosso, who has made some very remarkable observations on this subject, the readiness with which the supply of blood is increased in the brain by any sensory stimulus is one of those arrangements which may be traced to the survival of the fittest in the struggle for existence. This arrangement serves the purpose of increasing the supply of blood to the brain. The readiness with which the supply of blood to the brain may be increased induces a corresponding readiness in the development of energy; it thus enables an animal, at a slight warning sound or touch, to spring up from deep sleep thoroughly awake and active, so that it escapes the dangers to which it would be otherwise liable. It also gives the animal a better chance in a struggle, inasmuch as the one which can bring most energy to bear in a short time may overcome an animal stronger than itself on the average, but which cannot put forth so much energy at once. Although experimental observations on the direct effect of irritation of the fifth nerve upon circulation in the brain are not so complete as one could wish, we know that stimula-

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* *British Medical Journal*, November, 1873, p. 520.

† Taylor on Poisons, p. 805.

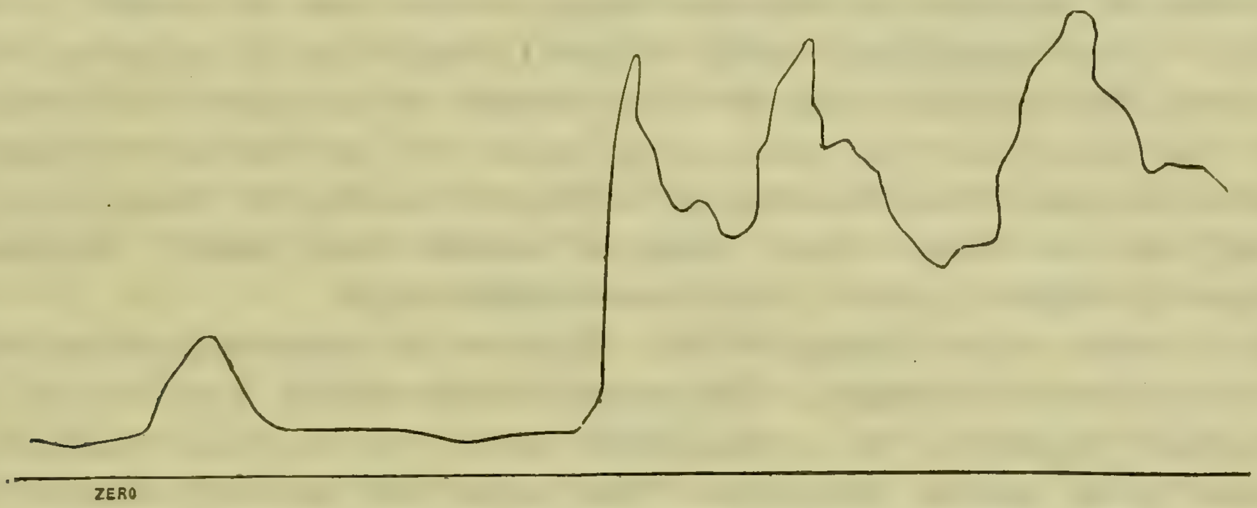

Fig. 2.—Diagram showing the Increase in the Rapidity of the Blood-stream through the Carotid Artery to the Head under the Influence of the Movements of Mastication.

The height of the curve above the zero line indicates the rapidity. The first part of the tracing was taken before, and the latter part while the animal was eating.

tion of its branches by mastication will greatly quicken the flow of blood through the large arteries which supply the brain with blood, for it is almost certain that the great increase in flow of blood towards the brain, which is shown by the accompanying tracing of Professor Marey's, is due to the nervous stimulus, and not to the mere movements of mastication. Besides this, we know that the branches of the fifth nerve are closely connected with the nervous mechanism which regulates the circulation in other parts of the body. Irritation of its branches usually increases the pressure of the blood in the vessels. The fifth nerve is distributed to the skin of the head and face, to the teeth, the mucous membrane of the tongue and mouth, and to the mucous membrane lining of the nose. Irritation of the nasal branches greatly increases the blood pressure, and it is this power which renders the application of ammonia or aromatic vinegar to the nose so useful in cases of fainting. In an experiment on this subject I found that, in an animal suffering from shock, the ammonia raised the blood pressure by one quarter of the whole.

It is an almost universal habit among people who are puzzled, to stimulate one branch or another of the fifth nerve by rubbing or touching it. Many people, when puzzled, rub or scratch their heads, or stroke their beard. Germans not unfrequently strike the side of their nose with the finger.

In all these ways a branch of the fifth nerve is stimulated, and probably the cranial circulation is increased. The pleasurable sensations from chewing tobacco are probably dependent to a considerable extent on the local stimulant effect exercised by the weed on the nerves of the tongue and mouth, perhaps even more so than on the general action of the drug in raising the blood pressure. When tobacco is used as snuff, it powerfully stimulates the nasal branches of the fifth nerve, and will probably affect the cranial circulation in somewhat the same way, though more powerfully than smoking. When tobacco is smoked, it has a double action. It stimulates locally the nerves of the tongue and mouth, and in those persons who are accustomed to draw the smoke not only into the mouth, but into the lungs, and expel it through the nose, it stimulates the nerves of the nose and lungs in addition to those of the mouth. It has, besides this, a marked effect on the circulation generally. I have noticed in a friend of mine, a distinguished physiologist and physician, that when trying to solve a difficult point, he is accustomed to light a cigarette and smoke for a minute or two, until the difficulty is solved, after which he at once throws the cigarette aside ; sometimes a few whiffs are sufficient, so that it seems very unlikely that sufficient absorption of any of the constituents of smoke has taken place to produce a general effect.

The effects of tobacco when smoked are not, however, to be entirely attributed to the nicotine which it contains, although it is probable that they are partly due to it. During smoking, the tobacco itself and the nicotine are exposed to considerable heat, and are to a considerable extent decomposed. It is the products of their decomposition, rather than the nicotine, which are actually inhaled, and which produce the characteristic effects. The substances which are produced by the dry distillation which the tobacco undergoes in the process of smoking are chiefly the volatile alkaloids pyridine, picoline, and collidine, with other bases nearly resembling them in character. These bases greatly resemble nicotine both in smell and in physiological action, producing, like nicotine, contraction of the pupil, difficulty of breathing, general convulsions, and death.*

Smoking, like snuffing, is sometimes used to quicken the mental faculties, or to "clear the head," as it is termed; and here it is almost certainly the reflex effect of its local action on the mouth and tongue which is produced.

When used for the mere purpose of enjoyment, and not as a stimulus to work, the effect produced by tobacco smoking is rather difficult to analyse. It seems to have a soothing effect, and to give an undefined feeling of pleasure, and when used in moderation may be continued for a long time without exercising any injurious effects whatever. When carried to excess, and generally when it is used for the first time, it produces intense sickness and depression, muscular weakness, and feeble pulse. The same symptoms which occur on its first use may be brought on by over-indulgence, even in those accustomed to it, and occur more especially when they use a stronger tobacco than usual. Death even may arise from tobacco smoking.†

The peculiar affection of the heart which it produces has already been noticed. Sometimes also it produces sudden fainting, which comes on without any warning. Occasionally there may be no apparent exciting cause; sometimes, however, emotional excitement aids the tobacco in producing the faint. As an instance of the first kind, a friend of mine told me that a young gentleman was one day dining at his house, and just as he was taking leave of his hostess, he fell suddenly insensible on the drawing-room floor. Another gentleman told me that while going some time ago to see a friend, he fell down suddenly insensible in the street. In his case slight emotional excitement had combined with the tobacco to produce the fainting. My friend, Professor T. R. Fraser, of Edinburgh, also informs me that almost all his college friends who had been accustomed to smoke to a considerable extent as students have been obliged to give up the use of tobacco as middle age approached, and that several of them have done so on account of being seized with fainting fits such as those I have described.

But besides these alarming effects of excessive tobacco smoking, there are others which are less serious. One is an irritable condition of the throat leading to hawking and spitting. Another is a condition of persistent dyspepsia. Another is an affection of the eyesight, which is thus described by Mr. Macnamara in his work on "Eye Diseases": "The patient usually finds that his sight has become somewhat suddenly enfeebled. The acuteness of vision is sensibly diminished, the patients, perhaps, being scarcely able to read numbers 8 or 10 test types, while in some cases they cannot distinguish even the largest type. A sort of white haze seems to envelop every object, and improvement generally takes place towards evening or on dull days, the haze being then less apparent. The perversion of the chromatic faculty is marked. Yellow, red, and green are often confounded with each other. These patients often see double or triple, probably on account of spasmodic contractions of the muscles of the eye. The pupils are not alike in the two eyes, one being generally larger than the other and often irregular. No other alteration is observed in the exterior of the eyes. Ophthalmoscopic examination in early stages of this affection often demonstrates serous suffusion, especially in the vicinity of the vessels. The arteries in some places exhibit spasmodic contractions, while the veins are tortuous and gorged. This disposition is observed to be more marked as the disease becomes prolonged, and then the papilla of the optic nerve is pale and whitened. De Wecker, however, states that he has never seen general pallor of the disc tending to atrophy in these cases.

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* Vohl and Eulenburg, Arch. Pharm. [2] cxlvii. p. 130--166.

† Taylor on Poisons, p. 806.

"From the above statement of symptoms it appears that tobacco and alcoholic amblyopia is an affection of the eye apart from atrophy of the papilla from other causes, such as neuritis or tabes. Tobacco amaurosis may even be completely cured, to return again after renewed excesses in drinking and smoking."

According to Galezowski, it is "due to paresis of the longitudinal dilating fibres of vessels, or spasmodic contraction of their circular fibres. The blood does not arrive in a sufficient quantity by the arteries, while the veins undergo a kind of passive stasis. The disease is a consequence of prolonged indulgence in tobacco and alcohol, especially when the latter is taken fasting or before dinner. Bad food and misery predispose. Complete abstinence from alcoholic drinks and tobacco for weeks or months is indispensable. The best treatment is bromide of potassium internally, and eserine lotion externally.

It is tractable at first, but afterwards it cannot be relieved.

The effect of tobacco is modified not only by the extent and way in which it is employed, but by the kind used. The strongest tobacco which is prepared for chewing contains only a mere trace of nicotine, and others contain none at all. That used for snuff also contains but a small proportion; the greatest amount is contained in the tobacco used for cigars.

In preparing tobacco which is to be converted into snuff, the dry leaves are moistened with water and made into heaps, and allowed to heat and ferment for some months. During the fermentation, a decomposition takes place in them: nicotine and ammonia are given off, so that they lose to a great extent their poisonous properties. They are afterwards again moistened with salt and water and allowed to ferment in close boxes, when their odour and pungency become developed. When tobacco is smoked, it is not the nicotine actually contained in the leaf which chiefly produces the effect upon the smoker, but the volatile alkaloids formed during the combustion of the tobacco. These alkaloids differ according to the mode in which it is smoked, and this appears to be the explanation of the well-known fact that very much stronger tobacco can be smoked in the form of a cigar than in a pipe. Indeed, if a smoker cuts up a cigar which he could smoke with pleasure into small pieces, and smokes it in a pipe, it is very likely to make him sick. According to Vohl and Eulenburg, the tobacco which is smoked in a pipe yields a very much larger proportion of volatile bases, and especially a large quantity of the very volatile and stupifying pyridine; while in a cigar little pyridine and much collidine is formed, the latter being less volatile and active than pyridine. The observations of Vohl and Eulenburg explain how it is that when tobacco cannot be had, other substances when smoked may produce a similar, though less agreeable, effect. They found that dandelion, willow-wood, stramonium, and even bogwood coal yielded, on dry distillation in a pipe, bases very much resembling, though rather weaker than, those produced by tobacco. They also think that the action of opium when smoked is not due to the alkaloids it naturally contains and which are not volatile, but to the products of their dry distillation. The effects of opium smoking no doubt differ to some extent from tobacco smoke, but this difference is probably due simply to different alkaloids being produced by the dry distillation in the processes of smoking from opium and tobacco.

But though dried leaves and dry wood when smoked yield bases which have somewhat the same physiological effect as tobacco, there is this great difference between them : that the taste of the smoke is not nearly so pleasant, and so men only smoke these substitutes when they are driven to do so by necessity. It is indeed quite extraordinary how the taste of the smoke is affected by slight differences in the condition of the substances used. Thus, it is well known in Europe that pigs' dung, when used to manure the tobacco plant, gives a peculiar flavour to the tobacco raised, and it is said that the Maronites of Mount Lebanon readily recognise the variety of manure employed in the cultivation of their tobacco by its flavour; thus, in those parts, that tobacco is held in highest esteem which has been manured by the droppings of the goat.

One great objection which is often raised to the use of tobacco is, that it leads to drunkenness. Tobacco, it is said, excites thirst; the thirst must be quenched with beer, or spirits and water; and hence the man who begins to smoke is led on to drink. There can be no doubt that in some persons the use of tobacco by smoking does produce thirst. This depends partly on individual constitution, and partly on the mode in which the tobacco is smoked. In some persons, smoking causes a profuse flow of saliva, so that they are obliged constantly either to swallow it or to expectorate it, and I am inclined to think that it is in such people that smoking chiefly excites thirst. In others, smoking seems to cause but little flow of saliva, so that they have no need to expectorate. Even those persons who are obliged to expectorate by smoking a pipe are not affected to the same extent, if at all, by smoking cigars, and where the smoke is drawn through water, as in a narghilé, or hookah, probably no thirst whatever is produced.

In countries where these forms of pipe are used, thirst is a thing much to be dreaded; yet I have seen Arabs after walking up a toilsome ascent, under a hot sun, stop for awhile in the middle of the day and light their narghilés. This they would hardly have done if it had any tendency whatever to produce thirst, as they had still a considerable distance to march before their day's journey was over. Probably this difference in the way of smoking is the reason why, both in this country and in New England, tobacco has been accused—and not altogether unjustly—of leading to drinking; whilst travellers in the East say, on the contrary, that it tends to produce sobriety. Mr. Lane, the translator of the "Arabian Nights," says that "being in a slight degree exhilarating, and at the same time soothing and unattended by the injurious effects which proceed from wine, it is a sufficient luxury to many, merely to pass away hours of idleness." Sir Austin Henry Layard, whose intercourse with Eastern nations has been still more extensive, entertains the same opinion; while Mr. Crawford, who quotes these opinions, and has also seen much of Eastern life, "thinks it can hardly be doubted that tobacco must, to a certain extent, have contributed to the sobriety of both Asiatic and European nations."*

In England and New England tobacco is smoked chiefly in pipes, and especially in short pipes, so that a much larger quantity of the volatile products of combustion, or tobacco juice, reach the mouth than when it is smoked in other ways. This tobacco juice is exceedingly poisonous: "one drop applied to the tongue of a cat brought on convulsions, and in two minutes occasioned death. The Hottentots are said to kill snakes by putting a drop of it on their tongues. Under its influence the reptiles die as instantaneously as if killed by an electric shock. It appears to act nearly in the same way as prussic acid. The natives of Cambambe, on the West Coast of Africa, poison the chamelion in a few seconds by drawing a straw dipped in the 'oil of pipes' across the poor creature's tongue and mouth."† When the narghilé is used, the whole of this oil is retained by the water through which the smoke passes; and in the very long pipe used in Germany, the oil falls into a reservoir and does not pass into the mouth. Another objection to the short pipe is, that it is said to lead to cancer of the lip, and there is no doubt that the constant irritation of the pipe resting against the lip has this effect in persons who are predisposed to it; without the predisposition it would not occur, for many persons go on smoking short pipes all their lives without getting it; but, on the other hand, it is probable that the predisposition alone might be insufficient to produce it without the local irritation.

BETEL-NUT.

The betel-nut is the fruit of a species of palm, the *Areca catechu*, which is found in India and in many other parts of Asia. It is chewed by the natives apparently for the same purpose as tobacco in this country, because it affords pleasure of some sort. The betel-nut, unlike tobacco, contains no substance having any marked physiological action on the body. Its chief constituents are a kind of tannic acid, which, with alkalies, yields a red colour. It is either softened by boiling it in water, or used when quite young and soft; it is cut into small pieces and rolled up with some lime in a leaf of the betel pepper. When it is then chewed it gives a red colour to the saliva and to the lips and tongue; but it is sometimes stated that the betel-nut is chewed for the purpose of producing this red colour of the lips, but this can hardly be the case. Its action is indeed very difficult to explain, unless we believe that it causes a free flow of blood through the brain by stimulating the mouth in the way already described when speaking of tobacco. On this view, however, its action becomes at once easy to understand, and its stimulant effects are readily intelligible, even although it contains nothing which acts on the heart, vessels, or brain directly.

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* Crawford: Journal of the Statistical Society, March, 1853, p. 52.

† "Chemistry of Common Life," p. 284.

TEA.

In almost every part of the world we find that hot infusions of the leaves of various plants are used as beverages; but the most important by far of all these is China tea, or simply tea; the other varieties of tea being distinguished by some appellation derived from the name of the plant used, or the district in which it is employed.

Tea consists of the dried leaves of a kind of camellia—the *Camellia thea*, sometimes called *Thea Chinensis.* It is probably a native of Assam; but it is now grown in immense quantities in India, China, Japan, Java, and the Southern United States. There are several varieties of it, which were formerly looked upon as different species. The name tea is from the Chinese têh. It was formerly supposed that the black and green teas were produced by distinct species of plant, but this is not the case. The difference is due to the mode of preparation. The commercial sorts of black teas are, Congou, Souchong, Oolong, Pekoe, and Caper; and of green teas, Hyson, Hyson Skin, Young Hyson, Twankay, Imperial, and Gunpowder.

The chief ingredients of both black and green tea are a volatile oil, an alkaloid known by the name of theine or caffein, and tannin. The chief difference between black and green tea consists rather in the amount of volatile oil than of theine—the amount of theine being almost the same in both. Both of them readily yield their active principles to boiling water, and both are chiefly used in the form of an infusion, the leaves being, as a rule, thrown away. There are one or two exceptions to this method of using tea. The Lipchus, on the Himalayas, prepare the infusion in the ordinary way; but after the tea has been drunk, the tea-leaves themselves are eaten. In Japan, also, there is a peculiar kind of fine tea, which is used only on most important occasions. It is of a pale green colour, and is ground into a fine powder. This powder is mixed with sufficient water to make it into a thin paste, and is then put into a small cup, which is handed round from one to another, each person taking it with both hands, and drawing a little of the thin paste into his mouth by a quick inspiration. This tea, which by the kindness of Dr. Dresser, I have had the opportunity of tasting, has a peculiar and strongly aromatic taste. Dr. Dresser, during his stay in Japan, was received by the Mikado, made a guest of the Empire, and had thus special opportunities of acquiring information. He informs me that this tea is very rare, and is used only on occasions of great solemnity; as, for example, in concluding the most important contracts. Amongst the Chinese, tea is infused only for a very short time. Boiling water is poured upon the leaves, and after standing for a few seconds only, is poured off and drunk. Long experience has probably taught them the advantage of this method, as by it they get most of the aromatic and stimulant effects of the tea without extracting the tannin, which tends to impair digestion. Taken in moderate quantity, the effect of tea is to cause a feeling of comfort with increased vigour of body, and still more of mind. It differs from alcohol and opium very markedly in this respect, that while the stimulant effects produced by these drugs are usually succeeded by depression, that of tea passes away without leaving any disagreeable after-effects, though possibly this is partly due to the primary effects of the tea not being usually carried to such an extent as in the case of alcohol and opium. In larger quantity, tea causes sleeplessness, and in larger still, produces excitement of the circulation, and such a disturbance of the nervous system that the patient suffers from hallucinations of vision and trembling of the muscles, somewhat resembling that in delirium tremens. These symptoms are produced much more readily by green than by black tea. In some exceptional cases, the susceptibility to the action of tea is so great that a few cups of green tea will bring on marked muscular tremors. Others, again, are so readily rendered wakeful by tea that they cannot sleep if they drink a cup after two o'clock in the day. Sometimes people suffer from sleeplessness without understanding the reason, when it is really due to their having drunk mixed tea, instead of black. They know the danger of green tea, and avoid it; but they sometimes drink the mixed tea without understanding that there is any green tea in it. Occasionally a cup of tea, instead of producing wakefulness, causes intense drowsiness. This is seen when a man has been engaged in hard work for many hours together, and feels very tired; but having still work to do, wishes to stimulate his brain by a cup of tea. He takes it, and to his disgust finds that he is at once seized with an overpowering desire to sleep. The reason of this, in all probability, is that the warm fluid dilates the vessels of his stomach, and by drawing blood from the already exhausted brain brings on the intense drowsiness. If the drowsiness can be resisted, it passes off after a little while; and when the tea begins to be absorbed, its stimulating effects upon the brain are felt. It has already been mentioned more than once that warmth is a most powerful stimulus to the heart, and the warmth of the tea has something to do with its stimulant action. Poor women, who are much underfed, and whose only comfort is a cup of tea, generally take it very hot, so as to add the stimulant effect of warmth on the circulation to the stimulant effect of the tea on the nervous system. The same class of people are accustomed to take their tea not only hot, but strong; and in order that no particle of its virtue may be lost, they infuse it for a very long time. In this way they extract a quantity of the tannin, and the combined effects of the tannin, and the excessively hot tea upon the stomach, produce a condition of dyspepsia. It is not improbable that the other constituents of the tea may have something to do with this, as well as the tannin, for a single cup of tea taken in the afternoon will sometimes bring on great acidity and heartburn in a remarkably short time, even when the tea has not been taken hot. When long infused, its deleterious action is much greater, and the Chinese plan of infusing it for a few seconds is very much better than that usually employed in this country.

Tea is, however, sometimes blamed for causing dyspepsia, when it is not really the tea so much as the manner of using it. Before any other food is taken, one or two large draughts of tea are swallowed, and then, perhaps, the food is hastily bolted without complete mastication. We have seen that the stimulus of food tends to produce secretion of gastric juice, and that mastication also aids in this process; but when a quantity of fluid is swallowed first, it tends to prevent the food which is taken afterwards from stimulating the walls of the stomach, and fluid drunk while food is still in the mouth washes it down, although it is so imperfectly masticated that otherwise it could hardly be swallowed. Mastication being consequently imperfect, the saliva is not secreted in any quantity, and thus two of the most important digestive juices being formed in insufficient quantity, digestion is imperfect, and dyspepsia is the result. Where the digestion is strong, it matters little what food the person takes, or when he takes it; but when the digestion is weak, attention must be paid to these minutiæ, and then it is advisable that when tea is taken with solid food, some of the solid food should be taken first, and well masticated before any of the tea is drunk. In such persons, also, it is better to avoid the use of tea together with butcher's meat, for in some way or other it seems to hinder the digestion of flesh more than that of farinaceous food. It has been said that this is due to the formation of tannate of gelatine, or leather, by the combination of the tannin in the tea with the gelatine in the meat. But whether this explanation be correct or not, the fact appears to be well established, that dyspeptics should avoid the use of tea along with, or shortly after, animal food.

As a beverage for quenching thirst during active exercise, few things are so good, and perhaps none is better than cold tea. In foreign travel, also, it is often advantageous to use weak tea instead of water. The water supply in many foreign towns is by no means good, and too often we hear of people who have gone abroad for health or pleasure, and have died while away, or shortly after their return, from typhoid fever. The germs of this disease are generally conveyed into the system by means of drinking water, and the danger from them is greatly diminished, and, perhaps, entirely removed by boiling the water before drinking it. But plain hot water, or water that has been boiled and allowed to cool, unless time has been allowed for its exposure to the air, is not a very agreeable beverage; whereas the addition of a little tea at once makes it pleasant. A most useful protection for travellers abroad, and especially for travellers in Italy, is to take with them a small etna and a little spirits of wine, so that they can boil a little water for themselves, and make weak tea whenever they wish. This can either be drunk hot at the time or cold afterwards, and by this simple precaution the danger from travelling is reduced to a minimum. In severe journeys, such as the expedition to the North Pole under Sir George Nares, tea is much to be preferred to alcohol. This was brought out very clearly in the report of the committee appointed by the Lords Commissioners of the Admiralty to inquire into the causes of the outbreak of scurvy in this expedition. In this report they state that the substitution of tea for alcohol in sledge travelling is attended with much benefit, and in the evidence which was given before them there was a general expression of approval of the tea carried by the sledge parties in the recent expedition, in the form of compressed tea. Tea is always preferable to alcohol for the mid-day meal; but, on account of its well-marked action in producing wakefulness, it is advisable not to use it shortly before the time of sleeping. Even at this time it is unnecessary to give alcohol, and all its advantages, without the risks inseparable from tea, may be obtained by the use of beef-tea at night.*

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* "Report of the Committee appointed by the Lords Commissioners of the Admiralty to inquire into the Outbreak of Scurvy," p. 25.

As a remedy tea is very efficient in many cases of headache, especially where this is of a neuralgic character. It should then be taken strong, and green tea is often more efficacious for this purpose than black tea. When tea is used in large quantity and infused long, so that it contains much tannin, it may give rise to constipation; but this is not usually the case when it is employed in moderate quantity and infused for a short time. In certain persons, indeed, it seems to have a laxative action.

The alkaloid caffein, or theine, which is found in tea, has been the subject of numerous investigations. When given pure to animals, or when taken by man, it seems to produce symptoms which remind us of the opium alkaloids, as it usually produces symptoms of excitement, but sometimes also of sleep. When given to frogs it produces tetanus, like thebaia; but it has also a very peculiar effect upon their muscles. In the ordinary frog of this country, the *Rana temporaria*, the muscles become stiff and rigid, as if dead, when a solution of caffein is applied to them, whereas this change is not produced in the muscles of the green frog, or *Rana viridis*, common in Germany. When very large doses are used, the tetanic convulsions are succeeded by paralysis and death. In warm-blooded animals the same condition of excitement is observed, and a slight touch causes them to shudder or fall into a tetanic convulsion. Moderate doses increase the strength and rapidity of the heart's beats and the pressure of blood within the vessels. The activity of the brain is usually increased, but sometimes sleep is produced; the temperature is not much altered, but is rather increased. The tissue change in the body has been said to be diminished by tea and caffein, but this is not quite certain. It is a useful diuretic increasing the amount of solids excreted in the urine, and is therefore a remedy of considerable use in cases of dropsy. We have already mentioned, when speaking of alcohol, that the long-continued use of intoxicating liquors tends to cause disease of the kidneys, with insufficient elimination of waste products. In such cases caffein is frequently beneficial, either alone, or still better when combined with other diuretics. The physiological action of the volatile oil with which caffein is associated in tea leaves has not been exactly ascertained, but probably a good deal of the effect of tea is due to this oil. The reason for supposing this is, that the amount of caffein in green and black tea is the same, and yet the effects of these two kinds of tea are very different. In China, also, tea is rarely used until it is a year old, as the new tea is said to have a peculiar intoxicating property. Persons engaged in packing and unpacking tea-chests are liable to paralysis after a few years' employment, and this has been attributed to the effect of the volatile oil upon them. It may, however, be simply due to poisoning by lead from the employment of lead foil in lining the chests.

Theine or caffein is contained, not only in the leaves of the tea plant, but in the leaves and berries of several other plants, which are also employed in the preparation of beverages. It occurs in the leaves and berries of the coffee plant, in the leaves of a species of holly which furnish the *maté* or Paraguay tea, and in the seeds of the *Cola* plant, used to prepare a beverage in Western and Central Africa. Besides these, a great number of other plants are used in various parts of the world as substitutes for tea. These are derived from many different orders of plants, but most of them belong to plants yielding tannin and a quantity of aromatic volatile oil, such as the *Myrtaceæ*, *Labiatæ*, and *Verbenaceæ*.

COFFEE.

Leaves of the coffee plant contain nearly as much theine as those of the tea plant, and more than the coffee bean. They are prepared by roasting over a clear fire, until they become of a greenish-buff colour. They are then separated from the twigs, which are again roasted, and the bark being rubbed off is mixed with the leaves. Their odour is very fragrant, and resembles a mixture of tea and coffee. With boiling water they give a clear brown infusion. When insufficiently roasted, the coffee leaves tend, like green tea, to cause sleeplessness, but when the roasting is complete their effect seems to be very much like that of tea or coffee. The coffee plant will bear leaves in some districts where it is not profitable to cultivate it for its fruit; and the natives in some places actually prefer the infusion of the leaves to the infusion of the bean, as being more powerful. The fruit of the coffee plant is a berry, containing two seeds, or beans, as they are popularly though incorrectly termed. These contain caffein or theine and a volatile oil having a powerful aromatic smell. This oil is developed during the process of roasting to which the beans are subjected before they are used. It is not produced in such large quantities from seeds which are perfectly fresh; and the best time between gathering and roasting differs with different coffees. Thus the small Mocha seeds will yield a full-flavoured coffee within a year of their being collected, whilst the larger American coffee, if roasted within a year, will develop but a poor aroma; and yet will become quite as aromatic as the Mocha if kept for seven or eight years. A mixture of two parts of Mocha and one of Java seems to yield a more aromatic beverage than either Mocha or Java coffee alone. The aromatic oil appears to be more volatile than in the case of tea, for coffee loses its aroma much sooner after roasting, and in order to be drunk in perfection, should be fresh roasted and fresh ground. Usually the coffee is made either by allowing boiling water to percolate through it, or else by simple infusion, and afterwards separating the grounds, either by allowing them to subside or by straining. In this country the grounds are usually thrown away as soon as the coffee is made.*

In Egypt the freshly-roasted bean, instead of being ground, is beaten in a mortar to an almost impalpable powder; it is then put with a small quantity of water and a lump of sugar into a little pan and gently raised to the boiling point, when it is drunk out of tiny porcelain cups, the size and shape of an egg-shell, usually set in little filigree silver stands.

The difference between the action of coffee and tea upon the nervous system is perhaps not very easily distinguishable. It is stated, however, that coffee tends to give more sharpness to the critical faculties than tea; and it seems to have a greater power of antagonising the effects of alcohol than tea; it is, therefore, not unfrequently taken in order to counteract the effects of slight excess in alcoholic liquor. The difference between the actions of coffee and tea probably depends upon a difference in the quantity and quality of the volatile oils produced during roasting. It has been stated that the caffein from tea and from coffee is different in its action, and that that from coffee is the stronger. But this statement probably depends upon the fact that the experimentalist in one case used the pure alkaloid in his experiment, and in the other used it in the form of a salt, which, being more soluble, would have a more powerful effect. The activity of the volatile oil is shown by the fact that a certain quantity of coffee produces as great an effect upon a man as nearly four times the amount of caffein which it contains; and that coffee injected into the veins of an animal produces general convulsions, and also a tetanic contraction of the intestine; while caffein produces neither of these effects. The residue of coffee from which the caffein has been removed also causes convulsions and stoppage of the heart, but no tetanus.

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* I was told at Smyrna that the best way of making coffee was always to allow some of the old grounds to remain in the coffee-pot. This I have not tried, but I can speak from experience of the excellence of the result of mixing Mocha and Java coffee in the proportions given above, as well as of the product of the Egyptian plan of making coffee.

Coffee is more apt than tea to disorder the digestion in many people, and in some is apt to cause a condition of biliousness. When taken in excess, it not only produces digestive disturbance, but nervous symptoms, palpitation, restlessness, irritability, sleeplessness, and general nervous depression. As a medicine, it is most useful in cases of poisoning by alcohol or opium : strong coffee being administered after the stomach has been evacuated by means of an emetic. It is sometimes used also to lessen nausea or vomiting depending upon the introduction of irritating substances into the stomach, and in cases of diarrhœa occurring after exposure to cold.

In most cases of dyspepsia coffee does not agree, and from its tendency to excite the nervous system it should also be avoided by those who are liable to suffer from various forms of nervous disturbance, such as functional palpitation of the heart and liability to attacks of neuralgia, hysteria, or epilepsy.

Coffee is not only often adulterated by admixture with other substances, but sometimes fraudulent imitations, which do not contain a particle of coffee, are sold under its name. The most common adulteration of coffee is chicory. This root is roasted before admixture, and it gives a slight bitterness to the coffee, which is to some so agreeable that they prefer the mixture of chicory and coffee to pure coffee. Beyond doing this and lessening the strength of the coffee (as the chicory contains no caffein), it has no injurious effect. Some coffees are made entirely of roasted figs. Other adulterations are roasted wheat and beans, flour, acorns, mangel-wurzel. To give it a colour burnt sugar is added. Some coffee is entirely made out of such substances. If no other adulterations are present, these substances are not actually injurious to health, only they have not the stimulating action of coffee. The infusion made with them is, in fact, a kind of toast and water, the burnt toast being replaced by burnt flour or burnt roots.

Chocolate and Cocoa.

Chocolate differs from coffee and tea both in its composition and in the method in which it is employed. Instead of being used as a simple infusion, it is made into a thin paste; and while tea and coffee are to be regarded as pure stimulants, chocolate is nutritive as well. The active principle of chocolate, also, instead of being caffein is theobromine. This is, however, very closely allied to caffein, the difference between them being that caffein contains in addition an atom of the organic radical* methyl, and is therefore methyl-theobromine. The cacao beans† contain about one and a half to two per cent. of theobromine, and six per cent. also in the husk of the bean.

Cocoa also contains an aromatic volatile oil which is probably similar in its action to that of tea or coffee, and like these oils is developed by the process of roasting. Cocoa differs from both tea and coffee in containing a very large proportion (almost half of its whole weight) of a peculiar fat which from its appearance is generally known as cocoa butter.

The fruit of the cacao tree (*Theobroma cacao*) is oval in form, about six or seven inches long, and usually marked with ridges. It contains about fifty seeds, about the size of almonds, embedded in a soft pulp. When the fruit is ripe it is opened, and allowed slightly to ferment, so that the seeds can be removed very readily from the soft pulp. Before using it is roasted like coffee, and the aroma appears to be developed in this process. It is then manufactured in three ways. Firstly, it is simply deprived of its husk and broken to pieces, which form cocoa nibs; secondly, it is ground, shell and all, between hot rollers, into a paste, and mixed with starch and sugar—it then forms cocoa; thirdly, the bean, after being shelled, is ground into a paste as for cocoa, and is then mixed with sugar and seasoned, usually with vanilla—this paste is chocolate. The purest form in which it exists is that of the cocoa nibs. When these are boiled in water they form a reddish brown decoction, and the fat being insoluble in the water, comes to the top, and forms a scum; this is removed, and the decoction flavoured with sugar and milk. When cocoa is used in this way it acts more as a pure stimulant like coffee or tea, and less as a nutriment. Oils and fats being, as is well known, often difficult of digestion, cocoa may be taken in this way by dyspeptics, in whom chocolate, which contains the fat, would produce biliousness or sickness.

The shells, which are separated from the beans before these are broken up for nibs or ground into chocolate, also contain theobromine; and when these are boiled in water they form a beverage which acts as a stimulant like coffee or tea, and may be used instead of them when they disagree, and when nibs are too expensive. These husks are usually sold at a cheap rate, and may be used with advantage by the poor.

In the preparation of cocoa, so as to form flake, granulated, rock, and soluble cocoa, the husks and the beans are ground together to form the best cocoa. An inferior sort is made from the smaller fragments of the nibs and a good deal of husk; and the lowest quality is made from the husk alone, with almost none of the bean in it. In some cases the cacao butter is removed from the cocoa during the process of its preparation, and this form is less likely to disagree with persons of weak digestion than ordinary kinds. The usual way of taking it is to put a large teaspoonful of the powder into a cup, mix it well with a very small quantity of boiling water, then fill up the cup, adding sugar and milk to taste. Chocolate is prepared from the bean without the husks, and is made into a cake; this is scraped down, and then mixed, like cocoa, with boiling water or boiling milk. It is not unfrequently eaten also in the form of bonbons or sticks, and when taken in this way it has a stimulant action on the brain reflexly through the nerves of the mouth, in the same way as smoking, besides having a stimulant action also after its absorption.

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* An organic radical is simply a group of atoms in such close chemical union that they behave, to a certain extent, like a single element; and methyl is a group of one atom of carbon with three of hydrogen.

† Cacao is the correct name of the tree and of the fruit and butter; cocoa, which is simply a corruption of it, is the name which is universally applied to the nibs and to the preparation made by grinding with starch and sugar.

MINOR STIMULANTS.

In Brazil a substitute for cocoa is used called *guarana.* The tree which yields this substance belongs to the same natural order as the horse-chestnut, and the seeds have just the appearance of small horse-chestnuts. They are prepared by pounding them in a mortar, and kneading them into dough with a little water. The paste is then made into round lumps or rolls like sausages, which are dried and hardened by the heat of the sun or a fire. These rolls are used in the same manner as chocolate, by mixing with hot water and sweetening the mixture. Unlike chocolate, guarana does not contain theobromine, but contains caffein, like tea or coffee. The quantity contained in it is very considerable, being twice as much as in good black tea, and five times as much as in coffee. It seems to have an action like that of tea or coffee; but, as it contains so much theine, and as a teaspoonful of guarana is used to a cupful of sweetened water, its effect is likely to be greater than that of either tea or coffee.

Like green tea, a cup of guarana is sometimes exceedingly useful in nervous headaches; sometimes it causes purgation, probably from containing an irritant substance called saponin. Saponin is the active principle in the Senega root, so much used in cases of chronic bronchitis, and we would expect that in this disease guarana might be usefully employed as a beverage in place of tea or coffee.

In Peru the natives are accustomed to use the leaves of the *coca* plant (*Erythroxylon coca*), which must not be confounded with cocoa. The leaves are dried and mixed with a little finely-powdered lime, and chewed in somewhat the same way as the betel-nut. In small quantities it is said to have the power of enabling men to make long-continued exertions without any inconvenience. When used to excess it causes dyspepsia, and sometimes also nervous depression and hallucinations. It is to be noted that it not only contains an alkaloid cocaine, and another volatile one, hygrine, but also tannic acid; and it is probable that its local effect in the mouth, and also the movements of mastication which it induces, have much to do with its stimulant action, as trials made in this country with it have not shown it to be much more stimulant than tea or coffee.

The *cola-nut* is used along the tropical parts of the Western Coast of Africa as a stimulant. These nuts are about the size of a pigeon's egg, of brown colour; when sucked or chewed they have a bitter taste while in the mouth; but they give a pleasant after-taste to water or to food, and the natives of Guinea generally take a piece of the seeds before each meal. They are also nibbled throughout the day in somewhat the same way as the betel-nut, and apparently act as a stimulant and give pleasure in the same way as the betel-nut does. When used in this way, however, they are said to injure the appetite. It has been stated that when made into a paste and swallowed they remove the effects of alcohol very quickly, and will render a drunken man sober in the course of half an hour.

Kava is prepared in the Fiji Islands from the root of a kind of pepper. The natives chew it into a pulp, and then mix it with water and strain it; but Europeans simply grate or pound it. It has a stimulating effect like coffee, is most invigorating, and, by stimulating the secretion of saliva, speedily allays thirst. When taken in large quantities it destroys the power of walking, but leaves the head perfectly clear. The only injurious effect which it seems to produce is, possibly, impairment of vision.

Another substance, which is sometimes regarded more as a food than a stimulant, but which is nevertheless a stimulant in reality, is extract of meat, or beef-tea. In addition to the albuminous principles of which meat chiefly consists, it contains a certain quantity of crystalline organic substances, and of organic salts, especially potash salts. These are soluble in water, and are extracted by boiling in the process of making soup or beef-tea. When meat is thrown suddenly into boiling water, its exterior becomes at once coagulated by the heat, and forms a kind of case which prevents the water from reaching the inside, and retains the juices of the meat. Thus, if we wish to cook the meat by boiling, we throw it at once into boiling water, so that it shall remain juicy; but if we wish to extract its juices, so as to make good soup, we must put it into cold water, and allow it to simmer for a long time, gradually raising it to the boiling-point. In making beef-tea, we proceed in a similar manner; but in this case the meat is to be cut up into small pieces, so that the whole of the soluble materials may be extracted. Beef-tea, then, contains inorganic salts, especially potash salts, soluble, crystalline, and extractive organic substances, and also some soluble albuminous substances, and gelatine. When the beef-tea is boiled before serving, the greater part of the soluble albumens are coagulated, and fall to the bottom as a fine powder. When a small quantity of water is used to extract the meat, it dissolves so much gelatine that it forms a complete jelly when cold. Gelatine alone will not sustain life; but it is a useful nutriment when given along with other things. This gelatinous beef extract is, therefore, food as well as stimulant. It may be made by putting two pounds of lean beef with half a breakfast-cupful of water into a jar, and allowing it to simmer for four hours in a pan of water. In this preparation, also, the soluble albumens are contained, as well as the gelatine. A still larger quantity of albumen is obtained by the method originally employed by Liebig to prepare beef-tea for his sick servant. To one pound of fresh lean beef, finely chopped, are added eight ounces of soft water, with five or six drops of hydrochloric acid, and a small teaspoonful of common salt. This is stirred, and left for three hours. It is then strained through a hair sieve, the meat slightly pressed to remove all the fluid from it, and to ensure this more effectually about two ounces more water are gradually poured over it towards the end of the straining. This must not be boiled, as the albumens would thus be precipitated, and must be taken either cold, or gently warmed by placing it in a vessel of hot water. It is of a red colour, which is to some people disagreeable; but this may be avoided by adding a little burnt sugar. This form of beef-tea is also very nutritious. Another kind, equally good and convenient, inasmuch as it may be kept constantly at hand, is Valentine's meat-juice. This is prepared by simply subjecting steak to enormous pressure in a hydraulic press, so that the whole of the juice is removed. This would be naturally apt to decompose; but it is evaporated *in vacuo* to a syrupy consistence. It then keeps perfectly well. One or two teaspoonfuls of this are added to a teacupful of cold or warm water, which, however, must not be boiling, or otherwise the albumen would be coagulated, but it may, however, be sufficiently warm to drink comfortably. Beef extract in the forms just mentioned is a very useful kind of food indeed for invalids who are able to take very little; but it is sometimes far too much relied upon, to the exclusion of other food, such as milk; and many people place reliance even upon ordinary beef-tea, or the ordinary Liebig's extract, for maintaining the strength of invalids, when these actually contain almost no nutriment at all.

In speaking of Liebig's extract we must distinguish carefully between the hydrochloric extract above described, which is nutritious, and the ordinary extract sold in pots, which is not a food but only a stimulant. This latter extract is prepared by the evaporation of beef-tea, and contains neither gelatine nor albumen. At first Liebig was inclined to ascribe to it great nutritive power, and to regard it as containing the same amount of nutriment as the meat from which it had been obtained. This view, however, was disproved by Voit, who showed that dogs fed upon meat extract quickly died. Liebig next supposed that although the meat extract was insufficient to maintain life, it would prove a useful addition along with other food. This view, however, was also disproved by Voit, whose experiments showed that not only did it fail to prolong life, but that in large quantities it acted as a poison. It is, therefore, of the very greatest importance that those attending upon invalids who are able to take very little food should not fall into the error of supposing that they can maintain the strength of the sufferer by the simple administration of beef-tea. On beef-tea alone the invalid will starve.

Milk, on the other hand, contains all the elements essential to nutrition, and much more reliance is to be placed upon it as a food than on beef-tea.

Yet, at the same time, universal experience shows that beef-tea has a very beneficial action both in maintaining the strength in disease, and in removing fatigue and exhaustion occurring in healthy persons. Part of its stimulant action is no doubt due to its warmth; but this is not all, for cold beef-tea will also act as a stimulant. The exact mode of action has not been precisely made out, but it seems highly probable that it increases the activity of all the muscles, voluntary and involuntary, throughout the body. It has lately been shown by Professor Ringer that the heart of a frog when removed from the body will continue to beat for some time when a very weak solution of common salt (chloride of sodium) in water, containing a mere trace of lime, is allowed to flow through it. After a short time, however, the beats become altered in character, but when this alteration has taken place, if a small quantity of a potash salt is added to the solution, the natural form and rhythm of the beat is at once restored. The extract of meat will have an action similar to that of the potash. A similar effect of small quantities of lime, soda, and potash on the voluntary muscles has been recently observed by Cash and myself.

The most important experiment, however, on the stimulant action of beef extract was made in the Ashanti campaign of 1874. This has already been alluded to when discussing the action of alcohol, but it may here again be mentioned, that while the stimulating effect of alcohol soon passed off and was succeeded by greater languor, each successive dose having less stimulating and greater depressing action, the extract of meat was quite as stimulating, left no after depression, and could be repeated without injury. It proved also more stimulating than coffee, and seemed to satisfy hunger and give strength, although it did not lessen thirst as the coffee did. The amount of meat extract necessary is about one ounce per diem. The coffee was better than the rum, but the quantity served out was probably insufficient, only one ounce being given, whereas probably no good effect would be obtained from less than two ounces.*

The advantages of beef-tea over alcohol under very different climatic conditions have also been pointed out by the Committee appointed to inquire into the outbreak of scurvy in the Arctic expedition. In the report they say "that there can be no doubt that the dietetic use of alcohol is to be interdicted in men suffering from any symptoms of scurvy; and wherever its deprivation is not opposed to custom or acquired habit, it would be advisable to refrain from its use as a regular ration in the usual condition of Arctic sledge travelling." At night, when tea would be inadvisable from its property of interfering with sleep, beef-tea is recommended in place of alcohol.

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* **Parkes on the issue of a spirit ration during the Ashantee campaign of 1874.**

EDUCATION AND THE NERVOUS SYSTEM.

By J. Crichton Browne, M.D., LL.D., F.R.S.

Lord Chancellor's Visitor.

Introductory—Body-Growth—Duties of Schoolmasters—School Registers and Life Charts—Tables of Height and Weight—Brain-Growth—Quantity, Quality, and Structure of Brain—Balance of Parts of Brain and Functional Habits—Blood Supply—Periodicity and Education—Diurnal Changes—Sleep—Duration of Sleep—Depth of Sleep—Dreams—The Promotion of Sleep—Morbid Modifications and Disturbances of Sleep—Nightmare—Night Terrors—Somnambulism—Morning and Evening Study—Lunar Changes—Seasonal Changes—Vernal Excitement—Epochal Changes—Teething—Puberty—Physical Education—Exercise—Evolution of Cerebral Centres—Either-handed Education—Gymnastics—Degeneration from Over-use—Food—Alimentativeness—Morbid Appetites—Starvation—Varied Diet—Intellectual Education—Precocity—Natural Education—Kinder-Garten System—Brain-Forcing—Effects of Brain-Forcing—Cranial Injuries—School Headaches—Examinations—Moral Education—Parental Responsibilities—Family Life—Monasticism—School Discipline—The Natural System—Artificial Penalties—Corporal Punishment—Express Moral Lessons—Healthy Literature—Self-Examination—Volitional Exercises—Religious Education.

"Everything," said the Right Honourable John Bright in his address at the opening of the Free Library in Birmingham, "everything that can be said on the subject of education has been said hundreds of times over"—a statement which might lead us to suppose that every question connected with education is settled, and the whole subject exhausted. But a very cursory glance around ought to satisfy us that this is far from being the case, that the subject still offers a large field for original inquiry, that it bristles with moot points, and that many useful words remain to be spoken respecting it. Whether we take that narrow view of education which restricts it to the art of the schoolmaster, or that broad view which includes in it every controllable influence that affects the growth and development of the human organism, it is equally clear that there is no finality in it, but that it must perpetually undergo changes reflective of the science and tendencies of the age. As the conditions in which human life is carried on become more and more comprehensive, education must increase in complexity, and as our knowledge of the laws of nature extends it must gain in precision. The current philosophy of a period at once shapes its education, and the scientific discoveries of a period exert a powerful effect on the education of the period next succeeding. But if this be so, we may surely look for great improvements in education shortly, for it can scarcely be but that the scientific discoveries of these days, and especially in the department of physiology, and concerning the brain and its dependencies, will bring about important changes in the system now in vogue. The new education, including elements drawn from all the great epochs of mental energy that the world has seen, will draw largely also on the stores which natural science has accumulated, and will avail itself of improved methods of instruction, founded on an acquaintance with mental and cerebral evolution, and with the laws of heredity and variation.

In a wide sense education and practical medicine have the same aim. The true conception of health is that it consists in the harmonious performance of all the functions of the being. From the lowest plant to the highest animal, we unhesitatingly assume the health of the being as the most perfect manifestation of its life, and to secure this most perfect manifestation of vitality is the object alike of the schoolmaster and the physician. They both strive to influence the organism so that it may be brought into conformity with the conditions of its existence: the schoolmaster, while inherent potentialities are becoming actualities, and while vital susceptibilities are most active; the physician, whenever the harmony of function has been disturbed. The methods of the schoolmaster are mainly psychical; those of the physician are mainly physical, but he would be a poor physician who ignored the facts of consciousness, and he would be a useless schoolmaster who gave no attention to the working of material forces. The schoolmaster may be the physician's best ally, by training the intelligence to the just appreciation of the conditions of health, and inculcating those principles of personal and social ethics from the neglect of which disease and death so often arise. And the physician may aid the schoolmaster in his task, by teaching the laws under which the union of the conscious intelligence and the bodily frame is maintained, and the conditions under which the capacities and faculties of the mind may be most successfully evoked and strengthened.

Seeing that education is necessary to health, and health to education, it has been thought expedient to say something of the co-relations of these in a work devoted to the consideration of health; and as the nervous system is that part of the human organism which is the field of education, upon the state of which its success or failure must depend, and upon the health of which it may exert a powerful and direct influence, it has been deemed well to connect education more especially with the care of the nervous system. The sound health of the body as a whole is, of course, essential to education, and so there is no section of this work which has not a bearing on that subject, and may not afford assistance to those engaged in rearing the young; but the sound health of the nervous system is even more immediately essential to education. Some hints for its preservation are, therefore, to be set forth in these pages, with information respecting the interruptions to which it is most liable. No attempt can be made within the limits imposed to deal systematically or exhaustively with educational topics; so those only will be touched on which seem to come into close contact with physiology and practical medicine, the object held in view being rather to warn against the dangers which threaten the nervous system in connection with educational processes, and to help to their recognition and avoidance, than to advocate any system of education, or propound any scheme founded on an exact analysis of the mental faculties, and the order of cerebral evolution, for which the time has not yet arrived. As all those intellectual acts which the educationist most desires to cultivate are dependent on certain physical changes in brain, and on cell-growth there, and as cell-growth in the brain is dependent on body-growth, we may begin by considering the relations of body-growth to education, in so far as these are known.

BODY-GROWTH.

The subject of education, notwithstanding all that has been written and said about it, from the time of Socrates and Plato down to the present day, is still involved in much confusion and obscurity. The practice or art of teaching, and the methods by which information may be conveyed, habits formed, or character moulded, have been empirically brought to some degree of perfection; but the science of education is still in a rudimentary state. A body of doctrines and maxims bearing on education have been handed down from past times, and are subjected to correction and improvement now and again; but the general principles upon which these rest have not been determined, and so routine has to take the place of intelligent adaptation to ever-varying circumstances.

The backwardness of the science of education, which many of our most successful educators have deplored, is to be attributed to two causes: a narrow and imperfect view of their obligations on the part of teachers, and an erroneous method, vitiating such investigations and experiments as have been attempted.

Teachers have, unhappily, hitherto failed to recognise the duty imposed on them, not only to instruct their scholars, but to study the principles of their art, and to record observations which may serve as guides to other members of their calling, and contributions to the general storehouse of scientific truth. Content to go through daily drudgery to satisfy inspectors, or to obtain certain results at examinations, they have neglected original research, and left unimproved the opportunities which they enjoy of advancing our knowledge of pedagogy. A medical man feels it incumbent on him not only to treat his patients, but to study disease and test remedies; and an engineer not only superintends the work entrusted to him, but designs and invents. A schoolmaster, however, seems to think that his mission finds its end in teaching. "Every hospital," says Mr. Francis Galton, "fulfils two purposes—the primary one of relieving the sick, the secondary one of advancing pathology; and so every school might be made to fulfil the primary purpose of educating the boys, and the secondary one of advancing many branches of anthropology." The conditions in schools are obviously favourable for all kinds of statistical inquiries. Boys of similar antecedents, age, and occupations are grouped together, and are under inspection for long periods, and the art of putting questions clearly and answering them succinctly has been brought by incessant practice to high perfection, so that returns of inestimable value on many psychological problems concerning the intellect, emotions, and senses might be procured if schoolmasters would only take the trouble of interrogating their pupils about their mental processes, and of collecting and analysing their written answers. "What excellent psychological work might be accomplished," says an author, who has given a notable example of the sort of inquiries that might be carried out in schools; "what excellent psychological work might be accomplished if a schoolmaster were now and then found capable and willing to codify, in a scientific manner, his large experience of boys, to compare their various moral and intellectual qualities, to classify their natural temperaments, and generally to describe them as a naturalist would describe the fauna of some new land. The masters, however, come and go, their experiences are lost, or almost so, and the incidents on which they are founded are forgotten, instead of being stored and rendered accessible to their successors ; thus our great schools are like mediæval hospitals, where care-taking was unknown, where pathological collections were never dreamt of, and where, in consequence, the art of healing made slow and uncertain advance."

But an erroneous or inverted method of viewing the subject of education, and of conducting such inquiries relating to it as have been undertaken, has done as much as an inadequate conception of the schoolmaster's mission to retard its development as a science. Education has been too much studied in relation to mind; too little studied in relation to body. The play of forces involved in it has absorbed attention to forgetfulness of the apparatus by which these forces are evolved, and the attempt has been made to regulate the growth of the faculties of mind without a just recognition of the fact that these are functions of body. It can no longer be said that physical health and muscular development are altogether neglected in our system of education. The time has gone past when we could say, as Herbert Spencer did twenty years ago, that the inhabitants of this country take an interest in the rearing of the offspring of all creatures except themselves, and that the feeding and training of animals are thought worthy of the consideration of a gentleman who would think it beneath him to bestow a thought on the feeding and training of human beings. The dependence of mind on body generally, and the importance of preserving health in the young in order that they may benefit by tuition, are now widely understood. It is admitted that teachers and parents ought to know something of the nature of the human economy and the laws of health, and that schools should be conducted on hygienic principles. Vast improvements have indeed been effected in regard to the diet, clothing, and cleanliness of children, whether in the nursery or in the school-room, and the provisions made for healthful exercise in playgrounds, gymnasia, and swimming baths betoken an awakening to the truth that "to be a good animal" is the first condition of success in life. But, nothwithstanding this marked advance in educational policy, it must still be alleged that the relations of body and mind are very inadequately understood by educators. Their conversion to muscular Christianity has been effected more by the observation of cricketers and oarsmen than by a conviction of the intimacy of the union of mind with brain, and while believing that sound health is necessary to sound thinking, they have not yet grasped the principle that the brain is the basis of the teacher's operations, that there is a constant parallelism between the development of the mental faculties and its growth, and that lungs, heart, liver, and kidneys—and indeed every organ and tissue in the body—are in constant communication with it, reflect in it their good or evil fortune, and are in turn affected by its weal and woe. Had our educators realised all this, they must have perceived that education is in one sense a branch of physiology, and to be studied by physiological methods, and we should then have had observations made which would have laid the foundation of a true science of education; instead of crude theories we should have had facts to rest on; instead of rules of thumb we should have had laws of nature. But the want of certainty about elementary facts has produced confusion in more advanced studies, and thus an erroneous or inverted method of inquiry has retarded the progress of education as a science.

Education being concerned with the growth of mind, and growth of mind being dependent on growth of brain, and growth of brain on growth of body, it might be thought schoolmasters would have hastened to determine the laws which regulate body-growth, and to show in what degree body-growth may be taken as an index of cerebral development. The most casual glance at a large school must satisfy any one that on an average the children are advanced in their studies in proportion to their height. The smallest are engaged on the alphabet, the tallest are working at Euclid and Horace, while between these extremes there are several intermediate standards, in each of which there is a general correspondence between progress in school work and stature. Both position in school work and height are of course in proportion to age. Now, if we asked a schoolmaster in what educational standard a boy or girl of twelve years of age ought to be, he would at once afford us the necessary information, but if we asked of what height they ought to be respectively, he would be unable to answer us. If we asked him : What is the annual rate of growth for boys and girls, and black and red-haired boys and girls respectively, between ten and fifteen years of age?—he would look aghast at our senseless curiosity. If we asked him how much a boy fifteen years of age ought to gain in weight for every inch gained in height, he would probably think we were insulting him, and show us the door. But these questions deal with facts that are at the basis of education, and the absolute ignorance of schoolmasters of these facts shows that education is not yet scientifically studied. We shall be able to show that the knowledge of the rate of growth is often essential to the safe conduct of education ; but it must be borne in mind that whatever information we do possess on this subject is derived from the labours of medical men, and not from those of schoolmasters. The latter, with ample facilities for collecting statistics of the most conclusive description, have supplied us with no jot of information, whereas the former, with very limited opportunities of observation, have gathered together data which, although not complete, are exceedingly instructive and suggestive. Schoolmasters should, however, be called upon to amend their ways in this respect, and henceforth to observe and note bodily as well as mental growth. School registers, on a larger and more comprehensive scale than any hitherto used, should be devised, and in these should be inscribed the following particulars regarding each boy and girl entering the school :—

1. Name.
2. Date of Admission.
3. Sex.
4. Birthplace.
5. Nationality of Parents.
6. Rank, Profession, or Occupation of Parents.
7. Causes of Death, and Age at Death of Parent or Parents, Brothers or Sisters who are not alive.
8. Age in years and months.
9. Height, without shoes, in inches.
10. Weight, in indoor costume, without shoes, in pounds and ounces.

11. Colour of Eyes.
12. Colour of Hair.
13. Girth of Chest.
14. Circumference of Head.
15. Strength of Arm.
16. Power of Sight.
17. Breathing Capacity.
18. Previous and Hereditary Diseases.
19. Previous Education.
20. Imperfect Development and Deformities.

Besides providing for a permanent record of particulars under each of the headings enumerated—or under such headings as might be decided on by the most competent authorities, the School Register should be so arranged as to supply a clear and complete history of the vital and educational progress of each boy as long as he remains in the school. His place in his various classes and examinations, and his conduct should be entered at stated intervals; and, in addition to these, accurate observations on his height, weight, chest and head girth, strength of arm, power of sight, and breathing capacity should be recorded at least once in every two months. The school report sent home to the boys' parents or guardians should contain information on these latter points as well as on his rank in class and diligence in the subjects which he may be studying. Of course illnesses and accidents of all kinds would be noted in the register, as well as all punishments inflicted, and their effects immediate and remote, together with all games and sports engaged in.

Numerous and cogent arguments may doubtless be advanced against any School Register such as that suggested. It may be ridiculed and denounced as useless and involving an absurd waste of time, and the difficulty or impossibility of obtaining the information required under some of its headings may be urged as fatal to the whole proposal. And yet, notwithstanding all opposition, it seems tolerably certain that, sooner or later, a register of the kind will come into general use in schools. Introduced in the first instance by a few practical and far-seeing men, its utility will soon become so apparent that other less enterprising schoolmasters will be compelled to follow their example, and ultimately public opinion, convinced of the value of vital statistics, will enforce its adoption in even the most obstructive and sluggish seminaries.

The labour involved in the keeping of such a register when it was once fairly set agoing would really be very trifling. Ten minutes or a quarter of an hour would suffice to make the entries on admission; and in a properly prepared room, with good apparatus, children might be submitted to those physical observations, which should be made every two months, at the rate of fifty or sixty an hour. But even if a large amount of toil and trouble were entailed by the register, the benefits likely to accrue from it would be sufficient compensation. The registers kept at various schools throughout the country would speedily become mines of wealth to statisticians and anthropologists, and the collocation and comparison of the facts contained in them would help to the solution of many problems of national importance. An analysis of the School Registers would enable us to determine the rate of growth of children in different districts, of different racial origin, and of different social position, from year to year; the proportion which weight ought to bear to height; the nature and peculiar effects of various influences at work in modifying the physical development of our labouring population; the effects on growth of the seasons of the year, hygienic conditions and diseases of hereditary and accidental origin; and the physical proportions most favourable to good health, and most suitable for various employments, as in factories, or in the naval and military services of the country. A scientific survey of the registers would soon afford us trustworthy information as to our real position, and settle the much-debated question as to the degeneracy of the race.

But more immediate and personal advantages would flow from School Registers, and it is the prospect of these that is most likely to lead to their institution. In prisons all the inmates are weighed once a month, and in many lunatic asylums the same practice is adopted; and in both these classes of institutions the advantages of such periodical weighings have been abundantly apparent. In prisons, the revelations of the scales have led repeatedly to the abandonment of a scale of diet which was surely undermining the health of those placed on it, but the insufficiency of which might have remained long undetected but for the testimony borne against it at the periodical weighings. In asylums, the mute warnings of the weight-book are constantly leading to the recognition of diseases in their incipient and curable stage, which would otherwise have run on undiscovered until they were beyond the reach of treatment. And can it be doubted that in schools the indications afforded by a register which chronicled nothing more than height and weight would often afford valuable guidance to public officials, schoolmasters, and parents, and prevent much suffering and sometimes life-long misery? Suppose the register of a particular boarding-school showed that the boys there did not increase in height and weight at the rate at which boys in their social position and circumstances ought to do in accordance with the recognised standards, might that not lead to an inquiry into the quantity and quality of the food supplied to them, and the disclosure that they were being subjected to slow starvation, with the result of a prompt stoppage being put to a process embittering and blighting young lives? Suppose, again, that on comparing the registers of two board-schools it were found that the children attending the one were, on the average, more stunted than those attending the other, and did not grow as fast; would not that be a good ground for inferring that they were not so well nourished, and ought to be excused for not passing so creditably through the trial of examination as their compeers in age but not in brain vigour? Suppose, once more, that the register of a public school demonstrated that a boy of fifteen had shot up suddenly an inch in two months—might not the fact go far to explain why he had fallen back in his work and been reported for negligence and inattention, and might it not also protect him from blame and punishment and from being goaded to exertions to which he was at the time unequal, and which, if persisted in, might prejudice his subsequent career? Suppose, yet again, that the register of a high school announced that a girl of seventeen still increasing in stature had abruptly ceased to increase in weight—might not that disturb the complacency with which a striking brilliancy which she had begun to manifest would otherwise have been regarded, suggesting that it was perhaps the phosphorescence of decay, and not the brightness of genius, and leading to an interview with the doctor, and her arrest on the threshold of consumption, upon which, but for the monition given, she would soon have entered beyond recall?

It is almost impossible to exaggerate the benefits that properly-kept School

Registers would confer on all concerned. They would give schoolmasters confidence in their work, and disentangle many of their moral perplexities. They would create a healthy competition among schools in the pursuit of health. They would put parents in the position to judge with precision and justice of the progress made by their children. They would aid in the prevention of degeneration and disease. They would help young men and women in choosing occupations for which they are physically and mentally well-suited. They would aid the State in fulfilling its duties, and they would serve to fix public attention on health as the basis of learning. That school that would acknowledge the principle of registration, and make a beginning in the practice of it, by appending a statement of the height and weight of each pupil to its monthly reports, would deserve well of the country.

There is another kind of register which ought also to be kept, and which would have an even higher personal than School Registers, although little direct, public value. We allude to a domestic or family register, containing some history of each member of which the family is composed. Nothing of the kind has existed hitherto, if we except the meagre annals of the family Bible, and even these, it is understood, have gone out of fashion. And yet it seems only common sense that a man should know something of his lineage, and should be able to recall the prominent incidents of his life journey, some of the most momentous of which happened before his own memory became serviceable, or have failed to leave a durable impression on it. The evils arising out of the want of knowledge of this kind are familiar to all medical men. They are often embarrassed in their treatment of disease, particularly at the outset of a case, by the patient's ignorance of his previous pathological troubles, and in five cases out of ten they would act with greater certainty and decision than are now possible if they had before them a statement showing family tendencies and the chief events in individual biographies. Insurance companies are, perhaps, best acquainted with the inability of immense numbers of persons, even in the cultivated classes, to specify the causes of death of their nearest relatives, or the nature of the illnesses from which they have themselves suffered. What is wanted is a life chart for every man and woman, which shall set forth their origin, and trace out their voyage, marking their rate of sailing at various times, the shoals and rocks they have encountered, the favouring currents that have carried them on. The life chart would include all the returns of the school register, but it would go far beyond these, for it would record height and weight at the moment of birth, and at regular intervals thereafter, the date of vaccination and of weaning, and of the appearance of the several teeth, the names and duration of all diseases that may have been experienced, and other facts calculated to throw light on physiological development and morbid proclivities. It may seem Utopian to hope that people will have intelligence and foresight enough to prepare charts of the description indicated, and honesty and perseverance to keep them faithfully. The bungling which takes place over the filling up of the simplest returns, the perfect indifference to vital history which leaves tens of thousands of persons in ignorance of their own age, and the folly and prejudice which lead so many to repudiate all family complaints, as if to conceal were to stifle them, do not certainly encourage the anticipation that we shall soon see life charts in general use.

But there is a growing recognition in some quarters of the truths that a man's present is the outcome of his past, that he must know his past in order to control his future, and that he cannot hope to understand his mental and moral past without some knowledge of the past of his physical organisation. Perhaps a few who have reached this stage of enlightenment may inaugurate the system of keeping life charts and the system may become a custom by and bye.

But in order that either life charts or school registers may furnish practical guidance, some standards with which to compare them are necessary. In the course of time, the registers and charts would themselves supply the best material for the construction of standard tables, but as an immediate return, in the shape of assistance in directing education, is one of the inducements towards keeping these records, such standards as are available should be made known meanwhile. And on some points, and these not the least important in the register and charts proposed, trustworthy standard tables are forthcoming, thanks to the labours of our anthropologists. On other points, again, we have no information that can be relied on.

It is as regards height and weight at various ages that we have the most ample information, for which we are indebted mainly to Dr. Charles Roberts, whose "Manual of Anthropometry" is a work of the highest value, which will yet, it is to be hoped, be much enlarged and extended.

The proportions of the new-born infant necessarily form the starting-point for the study of the development of the body, and so we refer, in the first place, to one of Dr. Roberts' tables, showing the height, weight, and chest-girth of new-born infants of the artisan class, founded on observations made in the Royal Maternity Hospital of Edinburgh, upon 100 male and 100 female infants. It is unnecessary to reproduce the table *in extenso*, the conclusions deduced from it being the only points of practical importance. These conclusions are, that the average height of infants born at the full period is 19·34 inches for males, and 18·98 for females; the average weight, 7·55 pounds for males, and 7·23 for females; and the average chest-girth 13·25 inches for males, and 12·65 for females. It will thus be seen that the height, weight, and chest-girth of new-born infants differ but little in the two sexes. With respect to the weight of the infant at birth and soon after, there is one remarkable fact that should be mentioned to prevent misapprehension and anxiety, in case weighing should be very diligently practised during the first few days of life, and that is, that during the first seven days there is a natural decrease in weight, so that, according to Quetelet, the weight of a baby a week old is less than it was at the time of birth. This is owing to the fact that the infant takes a little time to accommodate itself to its new condition, and to throw off its embryonic habits of life, and particularly in the matter of respiration. The respiratory changes in the tissues are much less active at this period than they subsequently become, and so less oxygen is consumed: the store of that gas in the blood having a less rapid demand made upon it. And thus it is that newly-born animals need much longer immersion in water before death by suffocation occurs, as they go on using the oxygen stored in the blood for their feeble respiratory processes. A full-grown dog rarely recovers after an immersion of a minute and a-half; but a newly-born puppy has been known to do so after being under water for fifty minutes.

According to Quetelet, there is a gain of about seven inches in height during the first year of life; but, as to the rate of increase in either height, weight, or chest-girth during babyhood, we have not as yet any satisfactory information. After four years of age, however, Dr. Roberts comes to our assistance with useful returns, showing changes in weight, height, and chest-girth in the artisan class from the fourth to the fiftieth year, from which the materials for the following table have been derived :—

TABLE

Showing the Average and Mean Height, Weight, and Chest-girth, and the Rate of Annual Increase in each, of Boys from 4 *to* 10 *years of Age belonging to the Artisan Class, and living in large English towns.*

Age.	Height.				Weight.				Chest-girth.			
	Average	Growth	Mean.	Growth	Average	Increase.	Mean.	Increase.	Average	Increase.	Mean.	Increase.
4	38·45	—	38·5	—	41·16	—	44·0	—	—	—	—	—
5	41·16	2·71	41·0	2·5	49·99	8·83	50·0	6·0	21·40	—	21·0	—
6	43·18	2·02	43·0	2·0	54·19	4·20	54·0	4·0	21·68	0·28	21·5	0·5
7	45·01	1·83	45·0	2·0	56·89	2·70	57·0	3·0	22·54	0·86	22·0	0·5
8	46·99	1·98	47·0	2·0	59·00	2·11	59·0	2·0	23·09	0·55	22·5	0·5
9	49·22	2·23	49·0	2·0	62·56	3·56	62·0	3·0	23·79	0·70	23·0	0·5
10	50·52	1·30	50·5	1·5	66·31	3·75	66·0	4·0	24·08	0·29	23·5	0·5

The measurements recorded in this table are only to be taken as standards of comparison in the case of boys of the artisan class, dwelling in populous towns; for it is certain that the rate of increase in height, weight, and chest-girth differs greatly in town and country boys, and in boys of the upper and lower social strata. Although this fact is established, we are, as yet, without the means of detailed comparison of boys of different classes at different ages under ten years; but after that age, thanks again to Dr. Roberts, we are enabled to contrast the growth and development of boys and men of the artisan class, inhabitants of towns, with those of boys and men of the most favoured classes of English society, drawn from both town and country sources, and being under the best existing conditions, as regards nurture, occupation, temperature, exercise, and sanitary surroundings.

The table dealing with the artisan class may be accepted as a standard of the physique of the English labouring population, living under unsatisfactory sanitary conditions, and engaged in arduous and insalubrious occupations, while that dealing with the most favoured classes is fairly representative of the best existing type of our English race, founded as it is on measurements taken at Eton, Marlborough, Wellington, Clifton, Radley, and other public schools; at the Universities; at Sandhurst, and at the Medical Schools. The results obtained are of great significance.

TABLE

Showing the Average and Mean Height and Weight, and the Annual Rate of Increase of 7,855 *Boys and Men, between the Ages of* 10 *and* 30, *of the Artisan Class—Town Population.*

Age last Birthday	Height without Shoes.				Weight, including Clothes—9 lbs.			
	Average.	Growth.	Mean.	Growth.	Average.	Growth.	Mean.	Growth.
	Inches.	Inches.	Inches.	Inches.	Lbs.	Lbs.	Lbs.	Lbs.
10	50·52	—	50·50	—	66·31	—	66·0	—
11	51·52	1·00	51·50	1·00	69·46	3·15	70·0	4·0
12	52·99	1·47	53·50	1·50	73·68	4·22	74·0	4·0
13	55·93	2·94	55·50	2·50	78·27	4·59	78·0	4·0
14	57·76	1·83	58·00	2·50	84·61	6·34	84·0	6·0
15	60·58	2·82	60·50	2·50	96·79	12·18	94·0	10·0
16	62·93	2·35	63·00	2·50	108·7	11·93	106·0	12·0
17	64·45	1·52	64·50	1·50	116·4	7·66	116·0	10·0
18	65·47	1·02	65·50	1·00	123·3	6·97	122·0	6·0
19	66·02	0·55	66·00	0·50	128·4	5·08	128·0	6·0
20	66·31	0·29	66·25	0·25	130·6	2·20	132·0	4·0
21	—	—	—	—	—	—	—	—
22	66·60	0·29	66·50	0·25	135·4	4·81	136·0	4·0
23 to 30	66·68	0·08	66·50	—	139·0	3·58	138·0	2·0

TABLE

Showing the Average and Mean Height and Weight, and the Annual Rate of Increase of 7,709 *Boys and Men, between the Ages of* 10 *and* 30 *years, of the most favoured Classes of the English Population—Public School Boys, Naval and Military Cadets, Medical and University Students.*

Age last Birthday	Height without Shoes.				Weight, including Clothes—9 lbs.			
	Average.	Growth.	Mean.	Growth.	Average.	Growth.	Mean.	Growth.
	Inches.	Inches.	Inches.	Inches.	Lbs.	Lbs.	Lbs.	Lbs.
10	53·40	—	53·00	—	67·4	—	67·0	—
11	54·91	1·51	54·50	1·50	72·9	5·50	73·0	6·0
12	56·97	2·06	56·50	2·00	80·3	7·39	80·0	7·0
13	58·79	1·82	58·50	2·00	88·6	8·27	88·0	8·0
14	61·11	2·32	61·00	2·50	99·2	10·61	98·0	10·0
15	63·47	2·36	63·50	2.50	110·4	11·21	110·0	12·0
16	66·40	2·93	66·50	3·00	128·3	17·92	126·0	16·0
17	67·84	1·46	68·00	1·50	141·0	12·69	140·0	14·0
18	68·29	0·43	68·50	0·50	146·0	4·97	146·0	6·0
19	68·72	0·43	68·75	0·25	148·3	2·20	148·0	2·0
20	69·13	0·41	69·00	0·25	152·0	3·87	150·0	2·0
21	69·16	0·03	—	—	152·3	0·27	152·0	2·0
22	68·93	—	—	—	154·7	2·44	—	—
23	68·53	—	—	—	151·7	—	—	—
24	68·95	—	—	—	149·2	—	—	—
25 to 30	69·06	—	69·00	—	155·2	0·42	154·0	2·0

On comparing these two tables, it is at once obvious that during the whole of the period which they both cover—that is, from ten to thirty years of age—the most favoured class has a mean height of about three inches greater than the industrial class. The difference in the height of those two classes shows a tendency to diminish at the earliest age, and although we may doubt whether Dr. Roberts is correct in thinking that if the observations were continued to the time of birth, the mean heights of the two classes would be found to be identical, we may still feel tolerably sure that they would gradually approximate as they approached that event. The inferior stature of the industrial classes is no doubt to some extent an inherited characteristic; but it is chiefly due to the continuous operation of various conditions of life, which retard and arrest growth, and which are most influential when growth is most rapid. That the height difference between the two classes is to some extent due to retardation of growth is evidenced by the fact that it is greatest at the great developmental period when the more highly favoured class shoots very decidedly ahead, and that afterwards it gradually diminishes as the less favoured class creeps through the phases of its more tardy evolution. The mean height difference between the classes is greatest at sixteen and seventeen years of age, when it amounts to 3·50 inches; at twenty years of age it has diminished to 2·75 inches; at twenty-five to thirty years of age to 2·50 inches. And the same truth is enforced by a reference to the time of commencement of the maximum growth-period, which in boys belonging to the non-labouring classes falls in the twelfth year, but in boys belonging to the labouring classes is delayed until the thirteenth.

As regards weight, the table exhibits a progressive gain on the part of the most favoured over the industrial class, both absolutely and in relation to height, throughout the whole of the period of life which is passed under review. And it is not difficult to understand how abundant nourishment and moderate exercise should conduce to an accumulation of tissue that is impossible under scanty feeding and wearing toil. At ten years of age, boys of the most favoured class exceed those of the industrial class by one pound in weight; at twelve, they have increased their advantage to four pounds; at thirteen, when early development on the one hand and retarded development and premature labour on the other have intervened to increase the disparity, the most favoured are ten pounds ahead of the industrial boys. At twenty years of age, well-to-do English youths have a mean weight of eighteen pounds greater than that of young handicraftsmen living in large towns. In chest-girth the most favoured class shows a superiority over the industrial, which is progressively increased until nearly adult life.

Another of Dr. Roberts' tables gives fuller information, derived from various sources, as to the heights and weights of 54,447 English boys and men of various occupations; and shows also the heights and weights of idiots and imbeciles in English public institutions; and of 4,630 boys and young men of American parentage, residing in the neighbourhood of Boston. Without reproducing this very voluminous table, we may state generally that it makes evident that children and youths of the professional classes living in the country exceed those of the same classes living in towns by about an inch in height at all ages from 10 to 20, and in an amount varying progressively from one to seven pounds in weight at all ages between 10 and 20; that the sons of soldiers, policemen, messengers, &c., are at the ages compared from one to four inches less in stature, and from four to thirteen pounds less in weight, than those of the professional classes; that the shortest and thinnest of our whole youthful population are the offspring of artisans and factory operatives; that idiots and imbeciles have a mean height of an inch less, even than boys of the artisan class, at all ages compared; and that American boys and youths correspond pretty closely in height and weight at all ages with English boys and youths of the same class.

The physical proportions of girls and women have, unfortunately, been very imperfectly studied in this country, but from America Dr. Roberts has obtained material for constructing a table showing the height and weight of nearly eleven thousand girls between the ages of five and nineteen living in the city and neighbourhood of Boston, these statistics having been collected by Dr. Bowditch. The tables, of which we furnish a summary, include all classes of the community, and therefore do not correspond with any of the classes of males given in English tables; but it fully illustrates the truth that the height of woman is less than that of man for three causes—firstly, because she is born a little smaller; secondly, because her annual rate of growth after the age of fourteen is less; and, thirdly, because her growth terminates about two years earlier than that of man. It is on the last cause above all that the difference in height depends; for while at the age of thirteen girls are a little taller than boys, at the period of full development women are on an average nearly four inches shorter than men.

TABLE

Showing the Average and Mean Height and Weight, and the Annual Rate of Growth, and of Increase in Weight in 10,904 *School Girls in the United States of America, between the Ages of* 5 *and* 19.

Age last Birthday	Height in inches without Shoes.				Weight in lbs. including Clothes.			
	Average Height.	Average Growth.	Mean Height.	Mean Growth.	Average Weight.	Average Growth.	Mean Weight.	Mean Growth.
5	41·19	—	41·0	—	39·66	—	40·0	—
6	43·35	2·16	43·5	2·5	43·28	3·62	44·0	4·0
7	45·52	2·17	45·5	2·0	47·46	4·18	48·0	4·0
8	47·58	2·06	47·5	2·0	52·04	4·58	52·0	4·0
9	49·39	1·79	49·5	2·0	57·07	5·03	56·0	4·0
10	51·34	1·97	51·5	2·0	62·35	5·28	60·0	4·0
11	53·42	2·08	53·5	2·0	68·84	6·49	66·0	6·0
12	55·88	2·46	56·0	2·5	78·31	9·47	76·0	10·0
13	58·16	2·26	58·0	2·0	88·65	10·34	88·0	12.0
14	59·94	1·18	60·0	2·0	98·43	9·78	96·0	8·0
15	61·10	1·16	61·0	1·0	106·0	7·65	104·0	8·0
16	61·59	0.49	61·5	0·5	112·0	5·95	110·0	6·0
17	61·92	0·33	62·0	0·5	115·5	3·50	112·0	2·0
18	61·95	0·03	62·0	—	115·1	—	114·0	2·0

It must be evident enough that we are yet in need of vast labour in the collection of statistics, and in arranging them and generalising from them, before we can obtain satisfactory standards for use in school-work. And what we particularly need are a series of observations carried on for a number of years on the same children. Observers hitherto have been content to measure once large numbers of children at given ages in schools, factories, and public institutions, and then to strike the average and mean for each age; but, as Dr. Percy Boulton has pointed out, we cannot thus learn to distinguish healthy growth from growth that has been interfered with by disease, nor can we hope to solve some other problems that are intimately connected with education. Dr. Boulton has himself made a most interesting contribution to the subject of the physical development of children, founded on personal observations carried on for ten years on the same children, who were all healthy, the offspring of well-to-do parents, well fed, housed, and clothed. The value of the conclusions at which he has arrived cannot be exactly determined, as he has not published the tables from which they are deduced, nor stated the number of children whom he has from time to time measured and weighed; but all that can be said is that if that number has been large his conclusions are of the highest importance, and if it has been small they are still worthy of attention.

Dr. Boulton says, "I find that average English children brought up under favourable circumstances grow from two to three inches a year. A growth of less than two inches or over three should excite apprehension. The former would indicate arrested development. The rate of growth should be regular, and being so prognosticates future good stature, because the healthy child that grows two inches a year passes five feet at about fifteen, which indicates a short stature (*i.e.*, if a male about five feet six inches, if a female about five feet one inch). The healthy child growing two and a half inches in a year is three feet two inches at three years, and passes five feet at thirteen to fourteen years. Such a child will be a medium-sized adult (*i.e.*, if a male about five feet eight; female, about five feet three inches). The quick-growing, healthy child that accomplishes three inches in a year passes five feet at ten or eleven, and eventually makes a tall adult (*i.e.*, if a male five feet ten inches; female, about five feet five inches). Of course one meets with many variations, but these variations are, I believe, always abnormal. Some children seem to do their growing by fits and starts, the common diseases of children arresting for a time their progress, and the loss thus sustained being afterwards made up by a supreme effort. Such growth is unnatural and often very detrimental. I believe, then, that every healthy child has its own regular rate of growth of two, two and a half, or three inches in a year, from which it has no right to vary more than a quarter of an inch in a year.

"Next as to weight for height. Whether a child grows two, two and a half, or three inches in a year, weight for height should be in each case identically the same, and all healthy children should grow broad in proportion to their height. Between three and four feet the increase in weight should, I find, be two pounds per inch, and between four and five feet two and a half pounds per inch.

TABLE.

Ft.	In.	Stn.	Lbs	Ft.	In.	Stn.	Lbs.	Ft.	In.	Stn.	Lbs.
3	0	2	8	3	9	3	12	4	5	5	2½
3	1	2	10	3	10	4	0	4	6	5	5
3	3	2	12	3	11	4	2	4	7	5	7½
3	4	3	2	4	0	4	4	4	8	5	10
3	5	3	4	4	1	4	6½	4	9	5	12
3	6	3	6	4	2	4	9	4	10	6	1
3	7	3	8	4	3	4	11½	4	11	6	3½
3	8	3	10	4	4	5	0	4	12	6	6

"Some children exceed these weights that are by no means giants, and really healthy, well-nourished children of healthy parents and in favourable surroundings generally attain these averages. But what of children that fall below the standard? I find there is a seven-pound margin of safety, and that children falling more than seven pounds below this standard are devoid of reserve of stamina on which to draw, and consequently succumb quickly to many constitutional diseases. This, therefore, may be called the preventive-medicine margin beyond which lies the dangerous land of Cachexia."

Dr. Boulton differentiates three different rates of growth in children, but he does not indicate what determines a particular rate of growth in any particular child. No doubt he would say inherited tendencies, but inherited tendencies may for this purpose be roughly summed up in temperaments, and these, betokened to some extent by the colour of the hair and eyes, with the nationality would, if carefully noted in a number of cases, enable us to form a judgment as to what rate of growth and ultimate stature to expect. We should expect a sanguine child with red hair and blue eyes, large blood-vessels and active muscles, of Scotch origin, to attain a greater height than a nervous child with black hair, brown eyes, small bony frame-work and feeble muscles, of French extraction.

BRAIN-GROWTH.

It is the supreme centre of the nervous system, the brain, that is the true field and ultimate aim of all educational operations. Enclosed in its bony case and membranes, it cannot be immediately observed nor influenced, but, linked, as it is, doubly by sentient and motor fibres with every part of the organism, and irrigated, as it is, in all its interstices by currents of blood, it can be indirectly modified in a vast variety of ways, and all educational processes have for their object the securing of certain modifications in its functions or structure. The limits of the power of education to modify the functions and structure of the brain are prescribed by the laws of inheritance on the one hand, and by those of variation on the other. Offspring resemble their parents down to minute peculiarities, and go through life charged with hereditary tendencies which remain potential, until the appropriate stimulation, which may consist either in external circumstances or internal processes of growth, renders them active. But offspring also exhibit individual variations, or new departures in function and structure, which arise out of the action of the environment in which they are placed, but which are limited as to extent and degree by hereditary barriers. Now, the influences that are summed up in education may be used to evoke some hereditary qualities, and to shut out from others those stimuli which are essential to their active manifestation, and also so to order and manipulate the environment that it shall favour and expedite individual variation in certain definite and desired directions.

But although thus limited in its power over the brain, education can still exert a potent influence over that organ, and can indeed make or mar it. It can affect, 1, its size; 2, its quality; 3, its elaboration of structure; 4, its balance of parts; 5, its functional habits; and 6, its blood supply.

Size.—The size of the brain is the most important consideration as regards its power. When the weight of that organ falls below a certain minimum standard, which may be fixed at 32 ozs., the possession by its owner of anything like human intelligence is impossible; while, on the other hand, men of great ability and attainments have brains very much above the average weight, which may be taken as 49½ ozs. for an adult male European. The brain of Cuvier, the naturalist, weighed 64½ ozs.; that of Dr. Abercrombie, the distinguished physician, 63 ozs.; that of Schiller, 63 ozs. If we contrast with these weights the observations made on brain weight in a number of idiots, some of whom have had brains weighing no more than 10 or 11 ozs., not much doubt will remain as to the importance of size of brain as a criterion of power. The average weight of the brain in cultivated races of mankind very much exceeds its average weight in less civilised races. Thus, the average weight of the brain in adult male Europeans is 49½ ozs., while in negroes it is only 44·3 ozs. And even in highly-cultivated races an appreciable augmentation in the size of the brain has taken place within the historic period, for Broca found that the average cranial capacity of 115 twelfth-century skulls of Parisians was 1425·98 cubic centimetres, whereas the average capacity of 125 modern Parisian skulls was 1461·53 cubic centimetres. At birth, the brain of the infant has an average weight of 13·87 ozs., and from this point it undergoes a progressive increase in weight to a period somewhere between the twentieth and fortieth year. All observations show that the greatest average weight of the male brain is in the middle of the decennial period between thirty and forty years, and this agrees perfectly with what we know of the continued development of intelligence during the whole of this period. In woman, the full average size of the brain is attained in the preceding decennium, between twenty and thirty years of age. That education is partly instrumental in increasing the size of the brain in the individual and in the race some of the facts already quoted strongly suggest, but a number of other facts establishing that proposition might be adduced. The Scotch, who have long been, as a race, better educated than the English, have an average brain weight of 50 ozs. against an average English brain of 47·8. The late Dr. Thurnam ascertained that the average brain weight of insane males, belonging to the more educated middle class in the York Retreat, was decidedly above that of paupers who died in county lunatic asylums; and Broca has shown that the dimensions of the heads of a number of students in the Ecole de Médecine were distinctly greater than those of a number of servants of the large hospital of the Bicetre. Le Bon has given a table showing the prevailing circumferential head measurements (which ranged from 52 to 62·5 centimetres) in individuals belonging to different social classes at present living in Paris, and who, from the differences in their modes of life, are accustomed to exercise their intelligence in different degrees. The measurements show a distinct decrease in the order of his four classes, which he designates—1, Savants et lettrés; 2, Bourgeois Parisiens; 3, Nobles d'anciennes familles; 4, Domestiques Parisiens. All students of cerebral development will concur in believing that the enforced use and exercise of the brain, at the time when its natural growth is going on, will accelerate and prolong that growth in the individual, and result in the transmission to his progeny of a tendency to greater brain-growth than they would otherwise have inherited. The difficulties and dangers attending parturition in women of civilised races, as contrasted with those of savage tribes, are almost certainly dependent on the increased size of the fœtal head, which is at once the consequence and the guarantee of civilisation. A large series of measurements of the heads of infants, children, and youths would be an invaluable contribution to biological science, and would probably throw much light on different methods of education.

Quality.—Brains vary as much in quality as they do in size, and range from what might be called the 24-carat brain of the man of genius down to the 10-carat brain of the dull country bumpkin. Their variations in quality, which depend, no doubt, on slight differences in chemical composition of the nerve substance, cannot be accurately assayed either during life or after death; they can only be roughly inferred from outward appearances, and from variations in the rate of nerve action. The rate at which a nervous impulse travels along a nerve to a muscle can be accurately measured, and this has been found to vary much in different animals. In a frog, such an impulse travels at the rate of 28 mètres per second, and in a man at the rate of 33 mètres per second. And in different individual men, the rate of nerve conduction varies slightly. But it is in more complex nervous operations that the influence of quality of nerve matter in determining rate of action becomes more manifest. Thus, as regards sensory impressions and voluntary actions founded upon them, the observations of astronomers show that of a number of persons intently watching for the transit of a star across the meridian some will record the event a third or even half a second earlier than others, the difference between individuals in this respect being known as the personal equation. M. Hirsh has shown that there are differences in the rapidity with which impressions are transmitted through the nerves of sight, hearing, and touch, and common observation affords abundant illustrations of different rates of action in nerve centres connected with mental processes. If a man, when out walking, asks his way, and receives some rather complicated directions as to the route to be taken, he will frequently repeat these directions aloud once or twice before he fully comprehends them. The words have been instantaneously received and appropriated so as to be capable of reproduction, but the interpretation of them takes appreciable time. The lower process has been rapid, the higher has been more deliberately performed. And common observation also affords abundant illustration of different rates of rapidity of mental processes in different persons, and thus guides to a rough estimate of the quality of brain matter. One man is spoken of as quick-witted, another as slow of thought. One is said to be vivacious, another lethargic; and for scientific purposes differences of this kind are summoned up in temperaments, in which rapidity of mental action and quality of brain substance are indicated by certain outward characteristics. From the nervous to the lymphatic temperament, through the sanguine and bilious and intermediate temperaments, conpounded of these, there is a gradual diminution in the rate of nerve action, and in the fineness of quality of nerve substance. This is, it must be admitted, but a crude classification, but practically it does serve to convey some idea of the sort of reactions that may be expected from the brains of persons of different outward appearances. The invariable tendency of education is towards the nervous temperament, and such a change in the quality of brain as shall quicken its action. The exercise which it involves modifies the nutrition of the nerve substance in such a way as to make it more rapidly responsive to stimuli. All civilised nations (independently of racial characteristics) are nervous when compared with barbarous ones, and educated persons are nervous when compared with those who have had no artificial cultivation. But the modification in nerve tissue, induced by education, may go too far, and then we have instability of nerve substance and the liability to nervous disease. Suicide always advances, *pari passu*, with education, and so do those nervous diseases that are dependent, not on general degeneration, but on an inherent vice in the nerve tissue.

Elaboration of Structure.—The grey matter of the brain which forms the coating of the convolutions varies in thickness in different regions, being thicker in the anterior than in the posterior part of the brain, and it has everywhere a laminated structure which is visible to the naked eye, but which becomes very apparent when the microscope is employed. It is then seen that it consists of five or six layers, according to the situation in which it may be examined, of ganglion cells of various sizes, spherical or oval, with an uninterrupted outline, or pyramidal, or stellate, and giving off one, two, or many processes or arms which unite with similar processes from other cells, are continuous with nerve fibres, or enter into networks. Besides the cells there are seen in the grey matter innumerable nerve fibres, derived from the white central stem of the brain and grey matter, or traversing it horizontally or obliquely from part to part, and forming an inextricable network; and besides these fibres there are seen a granular matrix or neuroglia, in which all the other structures are imbedded, and minute blood-vessels. But the structure of the brain is not always what has just been described, for at the period of birth all its cells are of the spherical and unbranched description, and it is only as life goes on that these little cells enlarge, bud, and put forth arms which join hands, as it were, with arms from other cells. The brain structure, at first simple, becomes gradually more complex and elaborate, and with the new communications established between cells and groups of cells come of course new possibilities of combined action. In the infant it is clearly owing to the impulse of impressions from without that the small uniform cells bestir themselves and extend their connections, and there is no reason to suppose that there is a change in the method of evolution at any subsequent period of growth. Evolution consists in the progressive integration of structure and function, and the passage from the simple to the complex, the general to the special. Even in the full-grown brain small round cells of the embryonic type are still abundant, and suggest the possibility of further educational development. Of the superficial area of every brain there is only a certain proportion that is under cultivation. Education is directed not only towards securing the best possible returns from the districts that have been brought under cultivation, but also towards encroaching on the waste territories, and compelling them to become fruitful of thought. But the waste territories can only be approached from those that are already tilled. Education must eat in upon their margins, and this it probably does by putting forth new branches from already cultivated cells. Education incontestably elaborates the structure of the brain, and enormously multiplies cell connections. And the probability is that it also leads to a multiplication of cells, for the cells of large brains are not themselves larger than those of small brains, and the greater size of the former therefore implies that they contain a much larger number of cells, and that the power of multiplication is therefore possessed by the nerve cells, at least at some stage of their existence. In old age the cells waste and break off from their connections, and the grey matter as a whole becomes shallower.

Balance of Parts.—The brain, it is now well known, is not a simple organ always acting as a whole, but a congeries of organs, bound up together and intimately united, and yet capable of more or less independent action. The surface of the brain presents a series of elevations and depressions which are technically called gyri and sulci. The gyri, or convolutions, were at one time believed to be irregular foldings like the twists of the small intestine in the abdomen, designed to give an increased surface of grey matter and facilitate packing, but not carried out on any general plan. It has now been ascertained, however, that these convolutions are invariably arranged according to a very definite plan, at least as regards their general features, certain minor details being left subject to constant variation. In every human brain there are always present certain great divisions and convolutions, just as in every human face there are invariably present two eyes, a nose, and a mouth. But in every human brain there are individual peculiarities, special diversities in the contours and dimensions of the convolutions, and in the number and arrangement of the secondary gyri, just as in every human face there are individual peculiarities in the size and form of its several features and in the number and arrangement of its lines of expression. The human brain can be divided into five lobes or main divisions, and each of these can be subdivided into several distinct convolutions. A high degree of intelligence is always associated with great convolutional complexity. In many of the lower animals, for instance amongst the rodents, there are no convolutions, the surface of the hemispheres being smooth. In carnivorous and ruminant animals the brain is convoluted, but its convolutions are few and simple, and are not arranged in definite lobes as in the human brain, but lie in tiers. In the brain of the spider monkey, a division into lobes and a foreshadowing of convolutional arrangement on the human plan may be recognised. But in the anthropoid apes, as the orang and chimpanzee, the method of arrangement closely approaches that seen in the human brain. At the sixth month of uterine life the brain of the human fœtus is smooth and without convolutions, but at birth the development of the principal convolutions is complete, many secondary ones, however, being still wanting. These secondary convolutions are formed during childhood and youth, but how late their development may go on we are as yet unable to say. The observations of Gratiolet and Marshall have made it clear that in women of the Bush race the arrangement of the convolutions is less complicated than in the average European brain—the greater simplicity being due to the paucity of the secondary and tertiary gyri, and to the less tortuous disposition of the convolutions generally. All data hitherto collected go to show that men of high intellectual capacity have possessed brains the convolutions of which were complex in arrangement from the increased development of secondary gyri and the greater tortuosity of the convolutions, and that idiots and weak-minded persons have brains that are not rich in secondary gyri and that are arranged in a way more or less approaching a fœtal type.

But the convolution is not the ultimate stage in the analysis of brain-structure and function. That the convolutions differ from each other in function has long been believed, and that different parts of the same convolution may have different functional activities may now be regarded as an established fact. The experiments of Fritch and Hitzig, and of Ferrier, on the brains of rabbits, dogs, cats, monkeys, and many other animals, have put it beyond question that the stimulation of certain portions of the surface of the brain with weak currents of electricity excites definite movements in certain limited parts of the body. In each case the animal experimented on was rendered deeply insensible by chloroform or ether; its skull and the membranes covering the brain were then removed, and to the surface of the brain thus exposed the electrodes were applied with this result—that when they touched certain determinate spots certain movements invariably followed. They were applied to one spot, and the animal wagged its ear, to another and it turned its head, to another and it stretched its fore-paw, to another and it bent its hind-leg. The same movements invariably followed the stimulation of the same spot; and spots, the stimulation of which cause entirely different movements, lie close together. By means of experiments of this kind a large portion of the fore and middle brain in the animals experimented upon has been mapped out into a number of precisely limited areas, or centres, the excitation of which is followed by definite and predictable movements, the extent and duration of which are always proportionate to the intensity and length of application of the electric stimulus. And in all animals these centres are arranged in the same order on the surface of the brain, and in the same or corresponding convolutions. Complete corroboration of the view that they are really centres controlling the movements which their electric stimulation induces has been supplied by another series of experiments, in which the removal of these centres by knife and cautery has been followed by paralysis of the particular muscle, or group of muscles, involved in these movements; but by this method of experiment, by the destruction of portions of the hemispherical cortex, together with the interpretation of many combined movements, a great advance has been made in our knowledge of the localisation of the functions of the brain. Thus, when removal of one convolution called the angular, the stimulation of which had caused movements of the eyeballs, was followed by blindness of the opposite eye, a result that did not follow on removal of any other portion of the grey matter of the hemisphere, the conclusion seemed irresistible that here was the centre of vision. By experiments of this kind, centres for hearing, touch, taste, smell, and organic sensations, like hunger and thirst, that are more especially connected with visceral conditions, have been determined. Some of these, perhaps, require limitation; but all the evidence that has yet been accumulated confirms the justice of the original localisation of the sensory centres.

Experiments such as we have been alluding to cannot be performed upon man, and it would be rash to infer that there was in his brain a construction and functional localisation, analogous to that discovered in beings so much below him in the scale of intelligence. But inference is not here necessary, for direct demonstration can be obtained. The human brain is constructed on the same type as that of the monkey, and essentially the same fissures and convolutions are recognisable in both, the chief differences consisting in the greater intricacy of the convolutional arrangement in the human brain, caused by the development of secondary gyri; but these differences never create any difficulty in determining the parts of the brain of man that correspond with those in the brain of the monkey. And the brain of man is perpetually being subjected to experiment by that archvivesector disease. Tumours grow in its substance, patches of inflammation occur on its surface, clots of blood are formed in many regions, degenerations invade its strands, and an observation of local lesions of these kinds, and a study of them with the symptoms exhibited during life, may conduct to trustworthy conclusions as to the functions of the parts affected by morbid change. The experiments of disease are not so precise as those of the physiologist, and cannot, like his, be varied at pleasure; but still they are eminently instructive, and promise in this matter of cerebral localisation to clear up the dense obscurities of the past. When we find that a small tumour, or blood clot, in the human brain, in a situation corresponding exactly with the centre for the movement of the leg in the monkey, causes paralysis of the leg, opposite to the lesion, and when we find that inflammatory irritation in the same centre causes disorderly movements, also in the opposite leg, we are entitled to conclude that the leg centre in the human brain is the spot corresponding to that which it occupies in the monkey brain. And when the same kind of evidence is obtained with reference to several centres, we are entitled to conclude that the centres in the human brain are arranged in the same order as in the monkey brain, and that in so far as their functions are identical the two are physiologically homologous. Additions are now being made daily, by intelligent observation of the experiments of diseases, to our store of facts bearing on the localisation of function in the human brain, and we are already in a position to indicate with some confidence the great motor and sensory centres. There are parts of the human brain, superadded to the monkey brain, which are neither sensory nor motor, and about the functions of which we can only speculate; and even those parts in which correspondence can be traced are larger and infinitely more highly evolved in the human than in the monkey brain; but still as regards differentiations of functions that are peculiarly human, we are not without important information experimentally supplied.

Now, all the centres that exist in the human brain may have their development retarded or advanced by the education that is applied to them. They must have stimulation and exercise, or they will not become functionally active, and each centre must have its own special kind of stimulation.

Functional Habits.—The currents of nerve force in the brain travel upwards and downwards and to and fro, and they always prefer to travel and diffuse themselves by the pathways of least resistance. And one way in which resistance is diminished is by the repeated passage of a current along the same pathway; and thus education, by laboriously opening up new pathways, and laboriously forcing a passage through them again and again, ultimately confers new mental habits. We all know how apt our thoughts are to run in old grooves, and Dr. Bastian thinks that such grooves actually exist in a physical sense. The delicate fibrillation of the cerebral nerve cells which is continuous with the fibrillation of their processes are, in his opinion, consequential to and gradually differentiated in the course of its functional activity. It is not unreasonable to expect that there should be a gradual marking out of the paths of habitual nerve currents through the previously structureless though slightly granular substance of the nerve cell during their passage from fibre to cell, and from one of these bodies to another. By frequent repetition education modifies the functional habits of the brain more and more as it goes on.

Blood Supply.—It is an axiom in physiology that organs which display great functional activity require an abundant supply of blood, and there is invariably a definite relation between the amount of work performed by any organ and the amount of blood that flows through it in a given time. The brain ranks as one of the most highly vascular organs in the body. Four large arteries convey the blood to it, and communicate so freely with each other within the skull that the most copious currents of blood are poured into its every part. By far the greater number of large blood-vessels penetrate the convolutions on the surface of the brain and descend from them to the deeper parts, giving off, as they do so, innumerable branches which form a network of capillaries in the grey or truly active brain-substance five times more abundant than that which they form in the white matter, or conducting tissue, of the brain. The arteries of the brain are not to be regarded as simple elastic tubes, capable of dilating under the force of the blood pressure due to the contractions of the heart, and of recoiling in the interval between each jet or wave of blood, but as pipes which contain in themselves a delicate, regulating apparatus of muscles and nerves, which controls the amount of blood transmitted in strict accordance with the functional and nutritive needs of the parts. If the brain is busily employed its vessels dilate, and copious streams of blood are sent through it; if it is at rest, the vessels contract, and the blood current flows with diminished volume and force. Any deficiency in the circulation within the cranium is accompanied by feebleness in mental manifestations; general depletion lowers mental energy, and if carried too far brings on violent convulsions. Weakness of the heart's action causes listlessness and depression of spirits, and there are several well-marked varieties of mental disease that are dependent on languor of the circulation and loss of tone in the blood-vessels, and that are best treated by remedies calculated to restore vascular tone. On the other hand, when the cerebral circulation is quickened the feelings are roused, the thoughts are more free and rapid. In mental excitement there is generally an unusual flow of blood to the head, as may be seen from the throbbing of the carotid arteries in the neck, and during severe mental exercise of any kind there is what has been called "a determination of blood to the brain," with a rise of temperature there and a fall of temperature in the hands and feet. And just as the circulation as a whole within the cranium is subject to increase and diminution, so it seems is the circulation in different areas of the cerebral mass, according to the functional and nutritive state of these areas. When the exposed brains of animals have, by means of electricity, been thrown artificially into a state of functional activity, hyperæmia or vascular turgescence has been invariably induced in the parts subjected to stimulation. We shall yet, in all likelihood, be able to map out many *quasi* independent vascular territories in the brain, corresponding generally with the sensory and motor centres or groups of centres. In the meantime we may feel sure that every demand made on the functional activity of any one area of the brain results immediately in a dilatation of its vessels and an increase in its blood supply. If excessive and too-long-sustained demands are made on the functional activity of any one area, they may at first conduce to its growth and augmented activity at the expense of other parts ; but they are most likely in the long run to lead to fatigue of the vessels and loss of their contractile power, with permanent congestion and general derangement of the cerebral circulation. The whole apparatus regulating the cerebral circulation in the young is more sensitive and mobile than it is in after life, and hence the facility with which educational demands are met up to a certain point and the danger of pushing them beyond that point.

The quality of the blood is not less important than its quantity in relation to nervous and mental activity. It must contain all the ingredients necessary for cerebral nutrition if it is to minister to healthy brain life. The addition to it of deleterious materials, such as narcotics, at once disorders the manifestations of that life and may abolish it altogether, and the withdrawal from it of certain elements may be not less injurious, as is seen in the effects of starvation. Feebleness of brain function is produced on an enormous scale and in innumerable degrees, from slight blunting of the fine edge of intellect down to complete fatuity, by anæmia, or poverty of the blood, resulting from deficiency of food, indigestion, hæmorrhages, over-work, and various states of ill-health or disease. The measure of anæmia is the reduction in the number of the red corpuscles or active oxygen carrying constituents of the blood. These corpuscles can now be readily counted in a given quantity of blood, and the degree in which they fall short of the standard of health can thus be estimated. That anæmia, however slight, is incompatible with good brain-work is already an established fact, and it is to be hoped we shall soon be able to fix a point, in anæmia, beyond which no educational work should be attempted. Brain-work, through its effects on digestion, is itself a frequent cause of anæmia, or rather perhaps one should say brain-worry, such as is set up by negligent and inconsiderate teaching. In most large schools boys may be encountered who are said to be backward because of their delicate health, which will not allow of close or continuous study. The explanation offered of the backwardness is doubtless correct in a majority of cases, but amongst these boys there are probably some in whom bad health is not the cause of their backwardness, but its consequence. Of anxious temperament and eager to excel, but badly grounded, and placed under teachers who bestow no pains on them, and among school-fellows who have had the advantage of better preliminary teaching, such boys stumble painfully along amongst ever-increasing obstacles, are ashamed of their own deficiencies, and, becoming disheartened and fretful, fail to make good blood, and pass into a state of debility, which still further embarrasses them in their school work. Taken away from the vexations and frustrations of their school life and placed with a discriminating private tutor, who will go back to the beginning, and guide them faithfully and wisely along the path of learning, such boys soon lay aside their delicacy, and become robust and enduring in body and mind. Whenever it is intimated that a boy's education must be interrupted because of his delicacy, strict inquiry should be made into the character of the education which he has undergone. Sometimes it will be found that it is the education and not the boy's constitution that is at fault. Bad, slovenly grounding is the cause of untold misery and much illness amongst boys, and perhaps amongst men also.

PERIODICITY AND EDUCATION.

All vital functions tend to run their course in fixed and recurrent periods, and, as is well known, Darwin has suggested that these periods, when lunar, may be traced back to the primordial origin of the vertebrata in marine animals resembling the larvæ of some existing Ascidians which were dependent on tidal changes, being copiously supplied with food and stinted at regular lunar intervals. The recurrence of this experience, it is argued, through innumerable generations has stamped a permanent habit on all the descendants of those tidal Ascidians—a habit which is still betrayed in the period of gestation of each animal, in the hatching of the eggs of birds, and in many other vital processes. But in human beings there are also very evidently cycles both of longer and of shorter duration than that of the moon's revolution, and the changes incidental to all such cyclical events are certainly of great importance in connection with the healthy development of the nervous system. These changes may be classified as—(1) Diurnal, (2) Lunar, (3) Seasonal, and (4) Epochal.

DIURNAL CHANGES.

The most prominent and most important, with reference to education, of all cyclical changes occurring in human beings are those which are diurnal in their recurrence, and include the alternation of the sleeping and waking condition. In all animals having a well-developed nervous system, sleep from day to day, or from time to time, seems necessary; and in animals whose nervous systems are not well developed, and in whom, therefore, the external phenomena of sleep cannot be readily recognised, it is probable that a state analogous to sleep recurs periodically. Even plants by their movements indicate that they have daily, as well as seasonal, periods of activity and repose. Leaves and cotyledons generally rise a little in the evening, and sink a little in the morning; and in many plants specialised sleep movements occur, always having for their object the protection of the upper surface of the leaf or leaflet from being chilled by radiation, and corresponding, as has hitherto been believed, with different degrees of growth activity. Dr. Siemens, as the result of his experiments upon the growth of plants under the electric light, has combated this notion, and maintained that, although periodic darkness evidently favours growth in the sense of elongating the stalks of plants, the continuous stimulus of light is favourable to healthy development at a greatly accelerated pace through all the stages of the annual life of the plant, from the early leaf to the ripened fruit. The latter is superior, Dr. Siemens says, in aroma, size, and colour, to that produced by alternating light and darkness, and the resulting seeds are not, at any rate, devoid of re-germinating power. Further experiments—and especially as to the retention of reproductive power by the seeds of plants grown under continuous light for several generations—are necessary before Dr. Siemens' conclusions can be accepted. And even if it were established that plants do continue to thrive in all respects for many generations under continuous light, it might still be that they have alternating periods of accelerated and slackened growth, corresponding to sleep and wakefulness. In order to prove that plants can do without sleep, it would be requisite to show that their growth under constant light is even and continuous, and does not occur at different rates at different times; for it is conceivable that plants accustomed to sleep in darkness might learn to sleep in light if no longer submitted to alternating light and darkness, just as men do under similar circumstances. A physiological pause might still occur, although the external circumstances determining that pause no longer happened. The recent observations of Herr Kraus, made with instruments of extreme delicacy, and proving that in all plant-organs there is a periodical swelling and contraction in the twenty-four hours connected with their variable water contents, are strongly in favour of the view that there is a rhythm of sleep and wakefulness throughout the vegetable kingdom.

But, whatever may be the case in vegetables, there can be no question as to the necessity for sleep in all the higher animals. And yet it cannot be said that the importance of sleep to life and well-being increases as we ascend in the scale of beings, and is in proportion to the development of the nerve-centres; for many of the lower animals—to say nothing of hybernation—spend a much larger portion of the twenty-four hours in sleep than man does, and, as far as can be ascertained, the lower races of men—such as negroes—indulge more largely in sleep than do the higher races—such as Europeans. Within each race, the more intellectually active members take, as a rule, less sleep than the more intellectually dull and torpid; and in each individual life the period of maximum mental activity is that of minimum sleep-indulgence. It is in babyhood and old age that most sleep is needed, and in the zenith of manhood that least is required. It seems that sleep is more immediately in relation with the formative than with the functional activity of the nerve-centres, and with the nerve-centres of animal than with those of intellectual life.

The drowsiness and prolonged sleep-periods of old age depend on special causes connected with involution, upon which we need not here enter; but as regards the sleepfulness of early life, it must be remarked that it is always in proportion to the activity of brain growth. From birth—when the brain is growing rapidly, and when life is almost a continuous sleep—onwards till manhood—when brain growth is at an end, and when only a third of existence is given to sleep—the increment of growth progressively diminishes, and *pari passu* with this diminution in growth goes a reduction in the demand for sleep made by the system. So it might, perhaps, be said that eight hours in the twenty-four constitute the amount of reparative sleep needed by a full-grown brain, and that all sleep beyond that amount prior to maturity—a quantity varying from one minute to sixteen hours in the twenty-four—is germinal sleep, connected with processes of growth and development.

Sleep has been called the "diastole of the cerebral beat," on the supposition that it is analogous to the moment of rest in the heart's revolution; and it has been ascribed as due to a slackening and interruption of the explosions of the protoplasm of the nerve-centres. But this view of sleep is founded on the assumption—perhaps now scarcely tenable—that the brain is always acting as a whole. If the brain be made up of many centres and groups of centres, which are not all active at one and the same time, it is probable that some of these are always in a state comparable to the diastole: that is to say, that they are at rest. And in this fact will probably be found the explanation of the more intimate connection of sleep with the lower and more animal functions of mind; for these, being more continuously active during working moments than higher centres that are less regularly exercised, will be more in need of definite intervals of repose. During wakefulness the senses are incessantly active, but attention is not perpetually strained, and the stores of memory are not being uninterruptedly drawn upon; and so, at the close of a day the sense-centres are exhausted, while those of the inhibitory-motor processes are perhaps comparatively fresh, having had many intervals of repose. A man engaged in intellectual pursuits finds ease and relief from fatigue in turning his thoughts away from their special subject to some new theme, or to the ordinary affairs of life, and so does not require to increase his sleep in proportion to his intellectual activity; but another man who lives in his animal activities cannot by any expedient rest these during wakefulness, and so has to proportion his sleep to the daily strains imposed on them. Infants and children live obviously very much in their animal activities, and on this ground, as well as on account of the rapidity of the formative brain changes in them, they require a large amount of sleep. Children do not require to increase their amount of sleep when they begin lessons; and, as a rule, even when their brains are not in the slightest degree over-stimulated or over-taxed in school-work, they sleep longer during the holidays than during term time—the reason of this being that the lower nerve-centres, the exhaustion of which is the measure of sleep, are severely exercised during hours of play. And so, again, excessive exertion of the very highest centres, either in children or adults, does not, as it were, by a natural rhythm end in sleep. After prolonged muscular effort or watchfulness, "tired Nature's sweet restorer" comes with a peremptory balm, and it is impossible to keep the eyes open; but after intense study sleep deserts the student, and the over-wrought centres are vigilant in spite of him, as if accustomed to take their repose in some other way than in slumber.

The inability to sleep experienced after arduous mental toil is to be attributed to the increased flow of blood to the brain, which is essential to great functional activity there. It has been suggested that the opposite condition, or a deficiency of blood in the brain, is the proximate cause of sleep; but to this theory it has been objected that even if anæmia, or bloodlessness of the brain, is a constant accompaniment of sleep, it may, like the highly vascular condition of a secreting gland or other active organ, be regarded as an effect or subsidiary event rather than as a primary cause. The blood-vessels were clearly made for the brain, and not the brain for the blood-vessels; and the amount of blood supply to the brain and its several parts is determined, not by vascular domination, but by the functional activity of the nervous tissues. When any part of the exposed brain is electrically stimulated, its vessels may be seen to dilate, some that were previously invisible coming into view, and the whole area blushing red from engorgement with blood; and it may reasonably be supposed that the same thing takes place during functional stimulation. And if hyperæmia accompanies functional activity, it may be confidently asserted that anæmia will accompany a suspension of functional activity, and thus it may be inferred that there is general anæmia of the brain during sleep, when the cerebral functions are very generally suspended. The sequence of events during the incursion of sleep is probably this: a number of nerve-centres are exhausted, probably from having used up their intra-molecular oxygen, and become functionally inactive and bloodless; the shutting out of external impressions by the closing of the eyelids, avoidance of noises and quiescence of the limbs, and the tranquillity of the motor-centre, connected with equilibrium, secured by recumbency, diffuses the state of functional inactivity and anæmia still further, and the circulation throughout the whole organ is soon reduced to a point that is incompatible with functional activity, but sufficient for nutritive purposes. And it seems that nutritive processes go on in the brain more freely and satisfactorily during the suspension of its functions. Not that nutritive functions are in abeyance during the day. No doubt they go on then more or less throughout the whole brain, and in some regions briskly; but in those centres where functional activity is pretty constantly kept up during wakefulness, it is only during sleep that nutrition can be adequately carried on, and especially that kind of nutrition upon which growth depends. And even the functional activity of the nerve-centres during sleep is not universally suspended. The centres of organic life maintain their indispensable functions, but in them, too, reduction of activity and some approach to rest are perceptible, for the pulse and breathing are slower, the intestines and muscular organs are comparatively tranquil, the temperature is lowered, and all the tissues in some degree participate in a state of repose. But all human experience is in favour of the truth that tissue nutrition is not abrogated in sleep, and that the brain and body generally are re-invigorated and built up again by sleep.

In connection with the influence of sleep on nervous development, the following subjects must be considered:—(1) Duration of sleep; (2) depth of sleep; (3) dreams; (4) morbid disturbances of sleep.

1. *Duration of Sleep.*—This, as has been already hinted, must be regulated not so much with reference to the amount of mental work imposed, as with reference to the age and temperament of the child. Moderate mental work creates no demand for an increased amount of sleep, and the evils of excessive mental work will not be compensated by it. Indeed, when mental work is excessive, it would generally be impossible to increase the amount of sleep, if it were desired to do so, for the

functional activity of the over-stimulated brain will not subside at the word of command, or when the ordinary conditions of sleep are secured. The duration of sleep ought to be in the inverse ratio of its intensity, those who sleep profoundly being fully rehabilitated by a period of slumber that would leave light sleepers still unrefreshed. But there is yet no good sounding-line to measure the depth of sleep, and so, all that can be said is that nervous children ought to be allowed to sleep a little longer than those that are of other temperaments. The following is the average duration of sleep required at different ages :—

4 years of age	12 hours	14 years of age	10 hours
7 „ „	11 „	17 „ „	9½ „
9 „ „	10½ „	21 „ „	9 „
28 years of age	8 hours.		

Children under fourteen years of age should be permitted to sleep a little longer in winter than in summer, and whenever bodily growth is going on rapidly an extra allowance of sleep should be conceded. Punctuality in the hour of going to sleep is of great consequence, as in this, as in so many other matters, the nervous system readily acquires a habit.

Any marked increase or diminution in the duration of sleep in a child or young person calls for a careful inquiry as to health generally, and particularly as to the health of the nervous system. Great drowsiness sometimes ushers in water on the brain, and insomnia, or persistent wakefulness, betokens at least a state of cerebral excitement, and may herald many grave disorders. When either of these conditions comes on suddenly, medical aid must be summoned, and when either of them is gradually established, the same step may generally with propriety be taken; for an excess and deficiency of sleep are in themselves detrimental to brain growth and evolution. The former is not often seen in these days, except in some pathological connection; but when it is encountered standing alone as a vicious habit in a naturally sluggish child, who has abandoned itself to lethargy, it must be firmly dealt with, for the brain that is steeped in somnolency undergoes degeneration. The latter, or deficiency of sleep, is an exceedingly common complaint in nineteenth century children, and is to be treated by the judicious and diligent employment of some of those means of promoting sleep to be hereafter enumerated.

Depth of Sleep.—Every one is conscious that the depth or intensity of sleep varies greatly from time to time. Sleep is spoken of as sound, deep, or profound, or as light, shallow, or fitful; and it is well known that even during the same night sleep may vary much in value at different hours. An attempt has been made to measure the depth of ordinary nocturnal sleep by the loudness of the noise required to wake the sleeper, and from experiments conducted in this manner it has been concluded that sleep increases very rapidly in depth or intensity at first, that it reaches its maximum within the first hour, and that thereafter it diminishes, at first rapidly, but afterwards slowly. At the end of an hour and a half it falls to one-fourth, at the end of two hours to one-eighth of its maximum intensity, and thence onwards diminishes with gradually diminishing decrements. This is in harmony with popular belief as to the value of the first sleep, and the superior restorative power of one hour's sleep before midnight over two after it.

Sleep is really a compound condition, much in need of analysis, and there are numerous kinds of sleep. There is a feverish, dream-crowded sleep, that brings no rest, but leaves the nerve-centres more worn and exhausted than it found them; and there is a placid and benign sleep, that gives genuine solace and refreshment. But, short of sleep, there are curious somnolent and sub-somnolent states that have as yet received no attention, but that are significant and well deserving of study. These somnolent or sub-somnolent states are very different from sleep, and yet they yield some reinvigoration. It has happened to many persons to lie awake all night, hearing the clock strike every hour—"never closing an eye," as the phrase is—and yet to have risen in the morning refreshed to a great extent, and ready for work: in a very different condition from that in which they would have been had they sat up all night reading or watching. And the day following a quiet night in bed is characterised by feelings very different from those experienced during the day following a night spent in an anxious vigil. There is unquestionably a certain periodicity in the re-awakening of the corporeal and mental energies, just as there is in their exhaustion; and the weariness of a night's watching passes off to a great extent at the usual hour of getting up, especially if the customary ablutions be carried out at that hour. But, beyond all this, there is a re-invigoration in the morning after a wakeful night spent quietly in bed which does not occur after a night's watching; and even a mid-day *siesta*, in which the eyelids never droop, is not without its restorative influence on fatigued nerve-centres, as well as on fatigued muscles. Children, therefore, should be induced to remain recumbent in bed, even when they protest that they cannot sleep, and no occupation or diversion should be offered to them to wile away the weary hours—the very weariness of which is, in some degree, calculated to recruit the vital powers. Sub-somnolent states are the next best thing to sleep, and are not only more likely to lead up to sleep than states of active attention, but yield themselves some measure of refreshment. Thus, too, a mid-day rest has its value, even although no sleep occurs during its continuance. All children up till three years of age should be made to lie down for two hours in the middle of the day, and this period will almost invariably be given up to sleep; but even when—as in the case of restless, nervous children—sleep cannot be obtained at this time, a rest should still be insisted on. With delicate, and especially with precocious, children, it is a wise plan to continue the mid-day rest till they are three or four years old, and to resume it even at a more advanced age should they manifest irritability or nervous excitement.

Dreams.—During even the most profound sleep there are always certain nerve-centres which remain in a state of activity, more or less reduced. That the activity of every centre is reduced is only what might be inferred when it is borne in mind that organs far removed from the cerebral hemispheres—and, indeed, all parts of the body—take some share in sleep, and have their rates of function slackened. And that certain nerve-centres, although with reduced activity, still continue to perform their functions during sleep is sufficiently obvious when it is remembered that the cardiac contractions and respiration, and other processes in which nerve-centres are involved, must go on uninterruptedly as long as life lasts. But besides the reduction of activity in some nerve-centres during sleep, there is cessation of activity in others; and between the centres in which function is temporarily abolished and those in which it is only slightly slackened, there are always others in which it is more or less completely suspended. And thus it is that we have so many varieties of sleep, ranging from the sopor, in which only essential organic processes are laboriously performed, to the most transitory doze, in which for a moment the head nods, and the senses lose their firm grasp of the environment. And thus, also, it is that we have so many varieties of dreams; for dreams are but the products of the faint activities of centres lying between the highest and the lowest, in which function is only reduced or partially suspended. Sleep spreads, it may be said, from above downwards. It invades the highest centres first (for until volition and perception are suspended we have not sleep), but after overflowing these, it is very variously and unequally diffused, and according to the varieties in its channels of diffusion over and through the cerebrum in different persons, and in the same person at different times, we have the varieties of dreaming. If the whole cerebrum is overwhelmed, sleep is dreamless; if large areas of it are left in a state of reduced but unsuspended activity, vivid and varied dreaming is carried on.

Some centres are apparently in a state of exalted activity during dreaming. The fertility of the imagination in this state, and the rapidity with which ideas arise, seem to point to an acceleration of function in some regions. These phenomena are to be attributed to the withdrawal of certain checks which in the waking state retard the free play of the centres that are concerned in fancy. Thus the will no longer inhibits or directs the currents of thought, and the friction of external impressions is removed, and thus a copious revival of previously experienced ideas, feelings, and emotions takes place; but the revival is faint, and becomes slow and fragmentary as sleep deepens. The theory that there is often a greater rapidity of thought during dreaming than in the waking state is quite untenable. To argue that because a man has dreamt in a few seconds a series of events which it might take him an hour to describe, he has therefore been thinking with lightning speed, is very much what it would be to maintain that because he can tell the whole story of some picture that he has only walked past, he must have gone through the incidents himself. Dreams are often analogous to pictures, and any one who wonders at their speed can never have measured his own rate of ideation when awake. A whole complicated series of events that could not be narrated in an afternoon may be reproduced in one flash of memory.

The statements that sleep is never dreamless and that some persons never dream are probably equally incorrect. Of course, in one sense, sleep is never dreamless: that is to say, if the word dream be made to cover all nerve action that persists during sleep, for the centres concerned with organic life are always busy; and hence the truth of Kant's words, that "without this wearying and salutary pain of dreams, sleep would be death." But in the more restricted and popular application of the word dream to a species of activity in the ideational centres, it may be safely alleged that sleep is often dreamless, and that all sleepers pass through periods of blank oblivion, haunted by no revivals of former experiences. On the other hand, however, sleep cannot be always oblivion to any one, for it is invariably approached through the vestibule of dreams, those incongruous ideas that drift through the mind as we are falling asleep being simple dreams mixed up with shreds of impressions from the immediate environment. In certain persons the transition from the waking to the sleeping state is very rapid, but in no one is it abrupt, like the change from light to darkness when the gas is turned out; and without exception there occur during this transition period motley ideas, which any sane man would be ashamed to acknowledge as the offspring of his waking intellect. As sleep inundates the brain, and as communication with the external world is more and more cut off, these ideas become more disjointed and more extravagant, until they either are effaced altogether by the advance of sleep which is then dreamless, or constitute themselves into what may be called regular dreams, in which special laws of association and suggestion come into operation. The notion of causation is to a great extent abolished in sleep, and a new nexus links successive phenomena together, while obscure sensations, that were unnoticed during waking hours, then obtain recognition, and may determine the character and course of the dream currents. The absence of all surprise in sleep at the juxtaposition of persons, places, things, and events which are widely apart in time and place is not wonderful when we reflect that a similar juxtaposition is constantly occurring in our day thoughts. We can jump mentally from the North Pole to St. Paul's Cathedral, from Tubal Cain to Wagner, without effort, and it is only because of the apparent externalisation of such "thick-coming fancies" in dreams that we feel in thinking over them that we ought to have felt surprised at their contiguity. But the externalisation was itself a fancy, and was not subjected to the verification of impressions derived from the senses. The moment that these intrude themselves into a dream, as in the processes of waking, the incongruity and incompatibility of its constituents become apparent, and its fabric falls to pieces. The real difficulty in connection with dreams is not to account for their absurdity, but to explain their coherence, the combinations which they involve, and the methods by which relations are established between experiences that were in their occurrence, and are in their nature, remote from each other. The fact that the old rather than the most recent stores of memory play the principal part in dreams, and that the experiences of childhood are perpetually welling up in them in adults and in old people, is to be ascribed to the fact that the deepest impressions on the sensory centres and those most susceptible of spontaneous revival (and it is the sensory centres which are chiefly concerned in dreaming) are those which were made on them when they were plastic, and undergoing development. Revived visual impressions enter into the composition of dreams to an amount that is disproportionate, even considering the predominance of sight as a sense in waking life. Dreams are, indeed, often spoken of as visions of the night.

It would be incorrect to say that dreaming is not a normal condition, and yet it is probable that the best and most restorative sleep is the most dreamless, and it is certain that diseased states are accompanied by a great increase of dream activity. Vivid agitating dreams are often the precursors of insanity; and almost every one knows how distressing dreams become to ordinarily placid sleepers during a feverish attack. Men have dream habits as well as habits of thought, and as long as they continue to pursue their customary rounds of nocturnal wanderings, even though they wander far and furiously, there is no reason for regarding these dreams as morbid. When, however, a sudden change takes place in the complexion of their dreams, or when one striking or distressing dream recurs with painful persistency, it is well for them to submit to medical inspection, lest some insidious degeneration should be thus declaring itself. For there is sometimes a pathological interpretation of strange dreams; and had one-tenth part of the attention that has been bestowed on dreams as omens of events been given to them as symptoms of disease, we should be in a better position than we are now to gather from them some useful warnings.

Of the utility of dreams, if they have any, we know nothing. That they keep up the continuity of consciousness and preserve personal identity will not now be argued. It has been hinted that in some obscure way they aid in cerebral development. Moonlight as well as sunlight is said to ripen the corn, and so it has been suggested that dream thought as well as waking thought may mature the intellect. The only fact known in favour of this suggestion is that people of active and cultivated intellect dream more than people who are stolid and unlettered, and of course this fact admits of another and more probable explanation. Dreams have as yet contributed practically nothing to human progress. A cantata, a poem, and the solution of one problem are all that we owe—if, indeed, we really owe this much—to the nightly dreaming of unnumbered millions through countless centuries.

The dreams of children are, more than those of adults, a reflection of their daily life, and, in consequence of their more excitable and nervous constitution, more prone to find outward expression. Many children talk in their dreams, and a few can be made to carry on a conversation with any one who has obtained a clue to their dream-thoughts. Over children, too, their dreams exercise an influence during waking life such as they do not often exert in later years. Children will dote on their dreams or tremble at them, and when bordering on nervous states, they summon up again as hallucinations phantoms which they have seen in dreams. What were at first faint revivals limited to the nerve-centre are propagated to the nerve trunk and periphery, and so affect these that genuine hallucinations are experienced. Jerome Cardan, the illustrious mathematician and physician of the sixteenth century, was a nervous and sickly child, and afflicted with unwholesome dreams. "As often as a hundred times there came before him in his dreaming, night after night, at intervals, a cock with red wings, at whose appearance the child trembled with the fear that it would speak, until it did speak in a human voice threatening words that took no hold on his memory. While lying awake in the morning before getting up, he commonly saw figures that were colourless, and seemed built up of rings of mail, rising out of the right-hand corner of the bed. The figures, following each other in a long procession, were of many kinds—houses, castles, animals, knights on horseback, plants, trees, musical instruments, trumpeters in the attitude of blowing, groves, woods, flowers, and wild shapes that represented nothing he had ever seen; these figures, rising out of the right-hand corner, and describing an arch, descended into the left-hand corner, and were lost. Jerome had pleasure in this spectacle, and made a secret of it."

The Promotion of Sleep.—Of the means available for promoting sleep in infants and children, the most important is the observance of regularity in the hour at which it is sought. A fixed hour for going to bed ought to be adhered to with the utmost punctuality, and no conversation nor reading in bed should be allowed to interfere with the advent of sleep. Light and noise should, of course, be excluded from the night nursery and dormitory, which should not, however, be left in a state of artificially secured pitchy darkness. A subdued light, from which the eyes of the sleeper are shaded, may pervade the room, or a few rays may be allowed to find their way into it from an adjoining apartment, so that there may be something for the eyes of the child to rest on should it arouse itself or awake suddenly. Paroxysms of terror, which may have serious consequences, are not rarely induced in children who find themselves on awaking during the night in total darkness. The exclusion of light is of more moment in relation to sleep than the absence of sound, for in time children learn to slumber placidly amidst constant din and uproar. Noises, however, in which they are interested have a powerful sleep-dispelling effect, and hence conversations in their hearing when they are trying to go to sleep are greatly to be deprecated. Such conversations when carried on in a subdued voice are even more pernicious than when they are conducted in ordinary tones, for the curiosity of the listening child is thus stimulated, while his attention is strained to catch what is being said, and a mental attitude very inimical to sleep is thus assumed. Monotonous sounds are very conducive to slumber, as all men know, and many babies and young children will not go to sleep without being hushed or having a lullaby sung to them. And monotonous passive movements have likewise a soporific tendency, and hence the cradle and the rocking-chair. One writer on education has stigmatised the rocking of infants as a pernicious practice, calculated to bring on congestion of their pulpy brains; but all experience is opposed to this conclusion, for it is idle to argue that what promotes natural sleep encourages cerebral congestion. The practice is, at any rate, a very primitive one, for female monkeys rock their young in their arms. The evils of rocking, such as they are, only become apparent when it is resorted to too soon after a heavy meal, or when it is of too violent a character.

A state of bodily and mental composure following upon active exertion is, of course, highly favourable to the rapid establishment and soundness of sleep; and hence the importance of securing a period of settlement, in which neither the muscles nor mental faculties are very actively exercised before the regular hour for sleep. Hence the importance, also, of banishing from the mind at this time all terrifying and harassing thoughts. Timid children are often kept awake by the fears which they conjure up when trying to go to sleep; for the brain, when in the transitional state between sleeping and waking, is, for reasons already given, peculiarly susceptible to the emotion of terror, and silence, solitude, and darkness, or a dim light, tend to foster grim and agitating ideas. An accurate record of the apprehensions and horrors that have haunted a number of young minds at this season would furnish material for an instructive chapter in mental embryology; and an explication of their detrimental effects upon health would afford some startling illustrations of the influence of mind upon body. Convulsions are sometimes induced by the imaginary terrors of this season, to which children are still very often heedlessly exposed. All young children, when put to bed, should have the feeling that they are not left alone, and the confidence that a word or a cry will at once bring a protector to their side. It is cruel and hazardous to leave them a prey to apprehensions which postpone sleep, and which often intrude into it and disturb it when it has at length overcome the little tremblers. Even boys and girls at an advanced age are not altogether exempt from strange dreads and awe-inspiring thoughts, which they would, perhaps, be ashamed to acknowledge, at this, the most emotional period of the day—the threshold, as it were, of a new world; and it is well that they too should then have the support which is derived from a sense of companionship.

The attempt to keep young children in ignorance of stories about ghosts, fairies, giants, and gipsies would probably prove futile. If they are of nervous and imaginative temperament, they will invent new terrors for themselves instead of the old traditional ones. A little girl of six, who had been jealously guarded against any acquaintance with nursery bogies and superstitions, suffered from night frights of a severe kind, in which she always screamed out that she was chased by poachers. Her father was a game-preserving squire, and it is presumed that she had derived from his conversation the images in which her alarms took shape. But while it may be impracticable to protect children from a knowledge of the supernatural and mysterious, it is inexcusable to frighten them with hideous stories, or to leave them a prey to the terrors of solitude and darkness.

The composure of mind which it is so desirable to secure as a harbinger of sleep is promoted, as has been already hinted, by allowing time before the bed-hour for the subsidence of all enforced mental activity. There should be at least an hour's interval between lessons and sleep; for if lessons be pushed up to the last moment, sleep will be driven away, or will be, in its first and most precious stages, broken and unrefreshing. Students and grown-up brain-workers should attend to this point, as well as the guardians of children. To turn resolutely from books and manuscripts at a fixed hour, and plunge for a little into a novel or newspaper, a game, or music, will often make all the difference between a bad and a good night's rest.

And bodily comfort is as essential to sound sleep as mental tranquillity, and in order to secure this for infants and children, various matters must receive attention. The ventilation of their sleeping-rooms must be regulated so that pure air may be obtained without draughts, and the temperature of sleeping-rooms must be maintained at a proper and uniform height. The young are very susceptible to cold, and possess but an imperfect power of generating animal heat; and in this country a very large proportion of infant mortality must be attributed to the effects of low temperature on immature organisms. During sleep the production of animal heat is diminished, and hence partly the danger of yielding to drowsiness when exposed to intense cold, and the frequency of catarrhs, caught by falling asleep in the open air unprotected by additional coverings. And it is better to maintain an adequate body-temperature in infants and children during the night by keeping up the temperature of the rooms in which they sleep than by heaping warm coverings upon them. The temperature of these rooms should be kept as near 58° Fahrenheit as may be practicable. Cold feet, which betoken feebleness of the heart and languor of the circulation, are a frequent cause of sleeplessness in children and young persons, especially young persons of studious habits or inheriting gouty tendencies. The discomfort and diffused sense of misery which they occasion, and the positive pain which they cause when chilblains have been induced by wintry weather, postpone and interrupt sleep, and lead to the adoption of postures in bed that are not conducive to health. The stony feet are pulled up, so that they may be warmed by the body, which is bent and drawn together as much as possible, and sometimes the head is put under the bed-clothes, so that the benefit of the heat of the expired air may be obtained. Such a style of reclining at night, of course, increases debility, and is apt to interfere with growth and carriage, and should be rendered unnecessary by the supply of artificial warmth to the child's feet. A strong prejudice exists against hot-water bottles or warm tiles in beds, but they are decidedly preferable to cold feet, and no hesitation should be felt in using them wherever they remove discomfort and encourage sleep.

From the first, every infant should sleep in its own cot, and at all ages children should have separate beds—the practice of placing them to sleep with nurses being now more than ever objectionable since Koch's and Creaplin's researches have thrown new light on the nature of tubercular disease, and made probable its communicability from one person to another. Cots and beds should be without curtains—draughts being avoided in other ways—and the bedding should be so arranged as to suit the child's style of sleep. The inclination of the body during sleep is a matter of no small importance, because it affects the cerebral circulation. Englishmen travelling in Holland and Germany are sometimes puzzled and distressed by insomnia, until they discover that their bodies, propped up by enormous square pillows, are at a much greater angle to the plane of the bed than that in which they are accustomed to repose at home. The substitution of a small pillow for the large one soon disposes of their wakefulness. And so with children: the inclination in which they are placed when put to bed should be attended to, as nightly variations in this may, at least, postpone the advent of the "coy visitor" whose ministrations are so essential to the welfare of growing brains. Very little things serve sometimes to induce sleep. Thus, the mere turning of a pillow, and application of its cold surface to the head and face, will on occasion prove the turning-point in a struggle with sleeplessness.

Innumerable artifices and expedients for the induction of sleep by means of mental operations have been devised and recommended by the victims of insomnia in all ages and countries, but these, when critically examined, resolve themselves into distractions from the high-roads of thought, and the monotonous and wearying pursuit of some almost mechanical mental process. The harassed merchant is urged to repeat poetry, the over-strung artist to dive into logarithms, and all and sundries are advised to count hundreds, to rehearse the multiplication-table, to follow the ticking of the clock, to think of the humming of bees, or imagine that the bed whirls round with them. A natural philosopher has recently made public his specific for inducing sleep, which consists in making the fingers of his right hand describe a series of circles, while he is thinking of the books in his library one by one. This device, which he considers an infallible cure for wakefulness if diligently carried out, he calls "marrying the mind to the body." But the difficulty in inducing sleep is rather to divorce the mind from the body—or, at any rate, to secure their temporary separation; and the natural philosopher's method is no worse and no better than hundreds of others of a like description that have been proposed. No doubt it suits his idiosyncrasy, and this is just a matter in which idiosyncrasy counts for much, and in which every man is best able to find out his own soporific. External impressions of a monotonous character act much like wearying mental repetitions; and so mesmeric passes and rubbings may encourage sleep, being most potent in this direction when aided by unquestioning faith in their efficacy. The sound of running or dropping water, for some yet unascertained reason, has a peculiarly soothing influence upon the nerve-centres, and promotes sleep more than any other external impression. This sound, which in certain diseased states—for example, in hydrophobia—is intolerable and maddening, becomes, in other states, exquisitely pleasing and tranquillising; and dying persons have been known to ask to have the contents of the water-jug poured into the hand-basin by their bedside, that they might satisfy a strange craving to hear the splash of falling water once again.

Stratagems to secure sleep such as we have been alluding to, and lures to tempt it, are chiefly found beneficial when sleeplessness is due to the irritability of a fagged or worried brain. The natural mental attitude to assume with a view to sleep is like the bodily one, an attitude of complete passivity. No fixing of attention should be attempted, no effort of memory tried: the thoughts should simply be allowed to drift. But when the cares and occupations of the day have been so absorbing and exciting, or so painfully interesting, that they cannot be laid aside at bed-time, but continue to obtrude themselves on notice, then some mental process that withdraws attention from the dominant ideas or emotions, and that is so mechanical that it can be kept up almost automatically, is, in some cases, useful. Only in mild cases, however, can such expedients avail, and only in them for a limited period. Business men in a state of high mental tension, students worked up to fever-heat, women anxious and fretful over their domestic duties, and fashionable persons distressed by *ennui*, soon find such devices vain, and have to look to changes in the physical organism as affording them the best hope of cure. In such persons dyspepsia generally exists. The dyspepsia may be of nervous origin, and attributable primarily to disturbance of the cerebral functions; or it may depend on errors of diet, or the excessive use of tea or alcohol; but whatever its origin, it must be set right before tranquil rest can be again enjoyed. The general principles of dietetics laid down elsewhere must be enforced, with this fact, however, borne in view: that the amount of food taken is generally in the inverse ratio of the amount of sleep enjoyed. The man who sleeps till nine in the morning seldom eats so hearty a breakfast as he who rises at five, and soldiers engaged in night duty, and sailors when they have additional night-watches, always require extra allowances of food. The wakeful dyspeptic, therefore, must by no means be starved, but supplied with plenty of easily assimilated food. The tendency of tea and coffee to produce wakefulness is generally recognised, but this truth must be noted: that they may still be the causes of insomnia when they are not taken in the evening nor for many hours before going to bed. If they are taken at any part of the day in such quantities as to produce their toxic effects, headache, tremors, and mental depression, they will infallibly cause sleeplessness at night, and so sleeplessness may often be successfully combated by depriving tea-bibbers of their favourite beverage, and reducing the consumption of coffee. Alcohol, too, when not taken to what would be called excess, may interfere with sleep. Thus, middle-aged men who take a larger quantity of alcohol than they are able to bear, although never so much as to produce the faintest sign of intoxication, complain that they cannot get sound and refreshing sleep, that they lie awake for hours together, that their slumber is broken by the slightest noises, that they are losing flesh, and suffer from nausea in the mornings, and all their symptoms are instantly relieved by total abstinence from alcohol in any form. On the other hand, it must be remembered that in persons unaccustomed to alcohol, a glass of wine or a little brandy at bed-time will often induce sleep, and that the addition of a small quantity of wine to the daily diet may, in certain cases, prove an excellent treatment of insomnia. So, too, a cup of coffee at bed-time may promote sleep, or even food at that time. The general rule is that no food should be taken for two hours before going to bed, but, on the other hand, a Scotch physician has declared that there is no narcotic equal to a plate of porridge and milk on getting into bed.

A warm bath just before going to bed tends to allay the nervous irritability which prevents sleep in children, whether caused by temper or work, and it does so probably by dilating the blood-vessels on the surface of the body, and so relieving hyperæmia of the brain. A warm mustard foot-bath—an excellent remedy for sleeplessness—is also beneficial, through its derivative effects.

The strictly medical remedies for sleeplessness are numerous and potent, but cannot with safety be employed except under medical advice. Incalculable mischief has been wrought by the use of active and dangerous drugs by mothers and nurses on their own responsibility. Such drugs, it is to be feared, are still largely used under deceptive and enticing names, as soothing syrups and cordials. Opium, henbane, chloral, bromide of potassium, and many other hypnotic remedies, may be given to wakeful children under suitable circumstances, with the most gratifying results, but no one but a medical man can judge of the suitable circumstances or choose the appropriate agent; and to use these drugs empirically is simply destructive. The brains of infants and children are singularly sensitive to narcotics of all kinds, and their growth will be surely arrested or distorted by the injudicious administration of any remedy of the class. Countless infants have been killed by black-drop—a well-named preparation of opium, which was at one time largely used in the manufacturing districts to pacify fractious infants—and by other proprietary mixtures of which opium is the basis.

Morbid Modifications and Disturbances of Sleep.—The first morbid modification of sleep to be mentioned is nightmare, which is really not very far removed from the vivid dreams above referred to, but which, however, must be classed as morbid. In nightmare certain impressions from the visceral nerves set up a state of limited, but intense, activity in a group of nerve centres, chiefly those concerned with motor processes, and ideas and feelings of a horrible and oppressive kind are experienced. An appalling danger threatens, but the limbs refuse to move, lying prostrate in a stony paralysis; a dread enemy pursues, and the body floats through space or falls from some tremendous height; or a mountain is piled on the chest, causing the pangs of suffocation. And whatever the shape may be which the organic horror assumes, the anguish of the situation ultimately finds outward expression. Groans are emitted, or there are wild cries or violent struggles, and then comes awakening with intense relief, but a lingering feeling for some time of fear and consternation. Nightmare may generally be traced to states of the alimentary canal, its most common cause being a full stomach pressing, owing to a supine position having been assumed, on the semi-lunar ganglia of the sympathetic system of nerves which lie behind it. But other disordered and diseased states of the abdominal organs may bring it on, and it may also be connected with heart disease. If repeatedly induced by heavy suppers, it may continue as a morbid habit after the objectionable meal has been given up; and further, it may occur as a sign of centric nervous disease, when it is of grave import. In every case of nightmare, however, one's first duty is to look to the stomach, and in a large majority of cases abstemiousness in the evening, with precautions against rolling or lying on the back during sleep, will effectually ward off the enemy.

In children, ordinary nightmare as seen in adults, occurs, but more frequently a variety of it called night-terrors. In this condition the child awakes out of a sound sleep, generally within two hours of going to bed, with a piercing cry, and will be found in its cot or bed quivering with fear, and screaming for help. Without recognising its parents or nurse, it appears to gaze at some appalling object, and passionately demands that it may be taken away. The surface of the skin generally is pale, but the face becomes turgid from screaming. The heart throbs violently. By degrees the little sufferer recovers a consciousness of its surroundings, its terror abates, and after a fit of weeping it falls asleep again, generally in a copious perspiration. Similar attacks may recur on many successive nights, or only at intervals of a week or more. The attacks all partake of the same character, and are always more or less distinctly associated with the impression of some menacing object—a dog, a lion, or a black man—which is supposed to be in or near the bed. When the attack is over the child usually falls asleep again, and sleeps soundly till morning. In rare instances a second, but milder, terror disturbs it a few hours after the first. The terrors may continue to cause nightly commotion in the household for weeks or even months, and in that case they tell upon the general health of the child, but more commonly they diminish rapidly in severity and frequency, and cease altogether in a week or ten days, leaving the little sufferer not much the worse. They are amenable to treatment, being, in nine cases out of ten, connected with some gastric or intestinal disorder, which yields readily to appropriate remedies. Children who experience night-terrors are, it must be allowed, of nervous temperament, and instances might be quoted in which water on the brain has followed on such terrors, but still it remains true that they are not commonly connected with primary cerebral mischief, and for the most part leave no unpleasant effects behind them. If the child who suffers from them is brisk and cheerful by day, shows no intolerance of light, and complains of no headache, confidence may be felt that the regulation of diet, aperients, tonics, and suitable medicaments will speedily dissipate these terrors, and ensure once more tranquil nights. When the terrors are obstinate under such treatment, a change of scene and air will frequently suffice to quell them; and this is especially beneficial when, as sometimes happens, an awful or shocking impression on the mind has been a factor in their production. Carlyle has recorded the sense of horror that was shot through many of his boyish days by one glimpse of the ghastly befillited head of his father's dead brother, from which a maid-servant, heedless of the child's presence, had for a moment lifted the coverlid; and De Quincey has left us a glowing imperishable picture of the trance of reverie and delirium that fell upon him, then six years old, on that midsummer midnight when he stole into the bedroom where the corpse of his little sister lay. Experiences of this kind—first intimations of the loathsome mystery of death—sink deeply into susceptible minds, and now and then, particularly when they coincide with physical disorder, stir up these nocturnal storms of fear which we have been considering, and which, when thus aroused, revolve round the image of a dismal umbrageous hearse or grisly skeleton. Night-terrors mostly affect children at an age when school-room education has not commenced, but when they come later, all lessons should be left off until they have been effectually dealt with.

Somnambulism is really a vivid dream, in which there is an unusual combination of centres in a state of activity, and in which ideal representations pass over into action. The feats of somnambulists have been greatly exaggerated, and it may be well doubted whether their sense of equilibrium and precision of muscular movement are so much exalted as to enable them to pursue with safety perilous paths, which sailors or steeple-jacks, with all their senses about them, would hesitate to attempt. Their dream impulses sometimes lead somnambulists into positions of danger, which their absorption in dream thought enables them to occupy without trepidation, but it cannot be admitted that they acquire while in this condition the agility of cats, or the supernatural gift of appreciating the position of objects which are not seen nor touched. Stripped of its poetical and mystical decorations, and looked at in the light in which it most frequently presents itself to the medical eye, somnambulism is an active dream state, lasting a few minutes, in which an excursion is made round a familiar bedroom, or a walk is taken down-stairs, or a number of senseless acts are performed. Somnambulists are often bruised and injured in their rambles: a fact which indicates that they do not exhibit special skill in avoiding obstacles. In rare cases the somnambulistic state is more protracted, and a complicated series of performances are carried on during its continuance, while external impressions, even of some violence, fail to interrupt it, or to gain access to the mind, unless they are in some way related to the dream current that is coursing through it. A murder has been committed during somnambulism, and quite recently a naval officer in this state, responding to the ideal cry of "A man overboard!" ran upon deck, denuded himself of his clothing, and jumped into the sea. In other cases of somnambulism it is alleged the dreamer is entirely under the influence of suggestion, and will fight, dance, whistle, or imitate any kind of animal, according to the directions given. Such cases must be exceedingly rare; and it may be safely predicted that persons subject to somnambulism of this kind will likewise exhibit hysteria, hypochondriasis, or the phenomena of hypnotism. The statement that somnambulists can make eloquent speeches, compose poems, and work out difficult mathematical problems, is simply incredible.

The commoner types of somnambulism are often met with in children, and may betoken inherited neurotic tendencies, bad habits, or over-stimulation of the brain. Examinations and evening parties may alike bring on sleep-walking. Children liable to sleep-walking must be closely watched. A grown-up person should sleep in the same room with them, the door and windows of which ought to be secured in such a manner that they cannot be readily opened. Violent exercise will not, as is sometimes supposed, prevent somnambulism; on the contrary, its tendency would seem to be to set up a state of excitability in those parts of the nervous system, the participation of which in a vivid dream constitutes the somnambulistic state.

A morbid or at least abnormal peculiarity observed in sleep, and one which causes parents much anxiety, consists in the habit of sleeping with the eyes partially open. There is something very disquieting in finding a sleeping child with the eyelids apart, its eyeballs turned upwards and exposed, and the pupils dilated. This state of matters is frequently seen in brain disease, and in adults, indeed, it is rarely seen unless brain disease be present, but in children it does not necessarily imply any existing morbid change in the nervous system, and may be merely a muscular trick, a trick, however, which nervous and scrofulous subjects are most likely to acquire. It has been observed at certain ages in eight children, all of one family, who have never suffered from nervous disease, and all of whom have grown up robust. When it stands alone, this sign of defective adjustment in the action of the eyelid muscles has no great pathological significance, but when it appears along with other symptoms of disorder in the nerve centres it presages evil. And the same may be said of the startings, twitchings, and contractions which so often occur during sleep, and especially when it is just settling down on the system, and which sometimes vastly interfere with its tranquillity. There are persons who never get to sleep without two or three violent jerks, and there are others who never move after they compose themselves to rest. It is only when movements are unusual in the person manifesting them or when they become exceedingly frequent and violent that they are to be taken as morbid to such a degree as to require treatment. These jerking movements are attributable to a state of unstable equilibrium and sudden explosive discharges in certain nerve centres of limited extent, and they occur chiefly during the invasion of sleep, because the unstable centres at once assert themselves when the control of the higher centres is withdrawn. And the unstable state of a nerve centre may result not only from an inherent unstable constitution, but from its disproportionate exercise;

and hence very active children and athletes are peculiarly liable to startings during sleep, which are observed also in animals called on for violent and sudden muscular exertion, and fed on highly nitrogenous food, as for instance in the *felinidæ* or cat-tribe. All unstable centres tend to discharge when emancipated from the control of higher centres, and hence it is that epileptic fits so frequently happen just as sleep is coming on, when also delirium first displays itself in fevers. This is indeed a favourite season for all convulsive and spasmodic disease. Cramp occurs principally at this time, and so do croop and child-crowing—a dangerous affection to which ricketty children are very liable, and which is marked by loud clangour of respiration and partial suffocation. Child-crowing, it has been declared, may be brought on by laying the child on its back, and so causing pressure on the posterior lobes of the brain through the bones of the skull which have been attenuated and softened by the ricketty state. More probably it is induced by nutritive changes in the brain itself.

Lethargy or sleep, deep and unusually prolonged, from which it is difficult to arouse the sleeper and into which he forthwith falls again, and coma, in which rousing cannot be effected at all, occur in children at the end of a train of morbid symptoms, and are rare as primary conditions. Coma points to grave changes in the cerebral circulation, congestion or effusion of serum, and lethargy to cerebral exhaustion. Lethargy in a child ought always to create a suspicion of convulsions which have escaped observation, and lead to watching accordingly, and also to strict inquiry about accidents and injuries to the head which may not have been reported. During debility and poverty of blood an inordinate amount of sleep is generally indulged in, as if the brain took a longer time to supply its wants from a diminished current of deteriorated blood than it does from a full and rich hæmic stream. Half-starved children are always drowsy and disinclined for exertion.

The diurnal changes in the nervous system demanding attention in connection with its healthful development and with education have not been exhausted when the altenations of sleep and wakefulness have been considered. There are other cyclical changes which take place in the organism and influence the daily manifestations of cerebral activity. The pulse shows clearly, running through all the immediate modifications which are dependent on the events of the hour, a rise and fall which cannot be accounted for by waking and sleeping, working or resting, by meals and intervals of abstinence. And corresponding with these variations in the pulse, there are variations in the quantity of carbonic acid given off during respiration; the *maximum* quantity being exhaled before and after noon, the *minimum* before and after midnight. In temperature, again, there are analogous variations independent of food or external circumstances, the *maximum* ranging from 9 A.M. to 6 P.M., and the *minimum* from 11 P.M. to 3 P.M. As regards secretion there is a marked diminution in the elimination of urea during the hours between midnight and 7 A.M. And along with these recurrent changes in circulation, temperature, respiration, and secretion, there are periodical alternations in innervation which may be regarded as dependent upon them or upon common causes. All the functions of the nervous system have a period of maximum activity before noon and of minimum activity before midnight. During the former, the senses are acute, the judgment is clear, and volition vigorous; during the latter there is more or less blunting of the powers of observation and reflection. That these changes are not really or solely dependent on the refreshment of sleep and the fatigue of exercise is evidenced by the fact, already alluded to, that they continue to recur even when no sleep has been obtained, or when the usual alternations of sleep and waking have been reversed. Amongst persons labouring under certain mental diseases the existence of this daily periodicity of nervous action, and its independence of exercise and repose, is often plainly demonstrated. Thus a great majority of melancholics suffer marked exacerbations of their symptoms every morning and marked mitigations every evening; and these exacerbations and mitigations are as distinct, when, as often happens, the patient is sleepless, as when he is obtaining slumber either natural or induced by drugs. The quickening of the physiological activity of the brain which takes place normally every morning, on its recurrence in the victims of melancholia, intensifies the morbid condition of which their despondency is the expression and their anguish is at its height. And the subsidence of cerebral activity which follows in due course every evening involves a retrocession of the pathological state, so that they are, comparatively speaking, tranquil and at ease. An inquiry into the maximum periods of mortality amongst the insane, and sufferers from chronic disease generally, has proved that deaths are most frequent just after the period of physiological depression, and most infrequent after the period of physiological exaltation of function.

Every observant man and woman knows that the mind is clearer and stronger in the morning than it is later in the day, and that the nerves are steadier before the meridian than after it, and one would naturally conclude that this universal law had been held well in view in all educational arrangements, the pressure of mental work being made to follow the curve representing the diurnal changes in brain function. At one time probably this was so, and at a first glance it might seem that it is so still. School hours fall mostly in the early part of the day, but a little inquiry will reveal that the heaviest part of school-work is not generally performed at that time. If any boy or girl be asked, "What is the most trying part of your school-work?" the invariable answer is "Preparation;" and if the further question be put, "When do you do your preparation?" the almost invariable answer is, "In the evening." This is a state of matters that is to be condemned from a medical and from an economical point of view. The most severe brain effort that the child is called on to perform, that which involves most strain and concentration of attention, that opening up of new ground on which progress must greatly depend, is reserved for the period when brain function is almost at its lowest ebb, and when all the vital powers are exhausted by the exertions of the day. The most severe and important intellectual labour is undertaken just when it is sure to be most injurious and least remunerative. Evening preparation of lessons if faithfully performed must be prejudicial to the fatigued brain, and is not even rendered innocuous by a long interval of recreation between it and school-work. It often induces sleeplessness, and a long train of attendant evils, and contributes largely to the nervousness and debility which are becoming so common amongst school children, particularly in towns, while it fails in securing advancement at all equal to what might be got from a much less strenuous and protracted study earlier in the day.

The most arduous mental work required of a child ought to be imposed on it when its mind and body are in their prime vigour, between 9 a.m. and noon, and certainly nothing but the lightest work should devolve upon it after 5 p.m. To the medical eye preparation seems to be peculiarly the work which should be carried on in school with the constant assistance of the master, whose special mission it is to explain difficulties, to remove obstacles, evoke interest, and stimulate endeavour. It is perhaps because some masters do not take this view of their office, but fancy that their duty is performed when they prescribe tasks, listen to the repetition of them, scatter over them a few critical remarks, and diffuse around them that magnificent moral influence which is not after all a good substitute for hard work, that tutors and evening governesses have so often to be employed to help boys and girls with their preparation, and that parents have to take upon themselves the real drudgery of teaching.

In many day-schools a laudable attempt is made to avert some of the hurtful consequences of evening preparation by asking parents and guardians to report to the head-master or mistress whenever more than a specified time is given up to this purpose, so that the amount of home-work may be lightened if the child is overburdened; but practically this attempt fails, because reports of the kind indicated are looked upon as reflections on the judgment of the teacher by whom the excessive tasks were prescribed, or as intimations of defective capacity on the part of the child. A nervous, ambitious child will toil on under a crushing load of preparation rather than have representations made with a view to a reduction of its burden.

Perhaps one reason why evening preparation of lessons is so universal is that a fictitious notion of its value is entertained. A vague version of what is called unconscious cerebration has gone abroad, and it has come to be believed that some mysterious operations go on in the brain during sleep, by which ideas that but for it would have been fugacious are indelibly stamped, and by which ideas are arranged and classified in a way that could not have been accomplished by waking skill and industry. A good fairy is supposed to be at work in the brain, while its conscious inmate slumbers, weaving threads of thought and churning fluid fancies into consistent recollections. Actors, it is alleged, who might have spent hours by day in committing their parts to memory, have learnt that by reading them once over before retiring to bed they can acquire them without further effort, the parts thus read over at night being registered in the mind in some inscrutable way, and capable of accurate repetition next morning. And so schoolboys, it is maintained, may be saved endless trouble by simply going over their tasks the last thing at night, and taking advantage of the hidden tide that leads on to knowledge. But without discussing the theory of unconscious cerebration, it may be suggested that the facts which are adduced in support of this particular phase of its operation are by no means established. It is not proved that any unconscious improvement of memory takes place during sleep. It is not proved that the actor commits his part to memory with greater facility in the way described than he would do if he read it once over in the morning and recurred to it a few hours afterwards. No doubt he thinks he does, because he has been accustomed to this style of learning by heart, and because he has not tried a more excellent way; but the only way to vindicate the superiority of the method of reading once over at night to that of reading once over in the morning would be to make a long series of experiments, noting the number of errors in each trial. It is comprehensible that the jaded brain at night might fail to recall instantly a string of words which it might recall easily when re-invigorated by sleep, just as a wearied rifleman, who made bad shooting in the evening, might hit the mark every time next morning when he had steadied his muscles by repose. But it would not be surmised of the rifleman that he had been practising at the butts unconsciously while snoozing, nor ought it to be said of the actor that his memory had been exercising itself during sleep. It is more than probable that the memory acquires most readily, firmly, and precisely in the early part of the day, and that it will retain most permanently and command most fully the possessions that it then acquires. And if this be so it is clear that all night work, such as reading over lessons before going to bed, should be forbidden to children, and that their most important work should be taken in the morning, that which is of a less weighty and engrossing character being reserved for the latter part of the day.

LUNAR CHANGES.

The discussion of the factor of periodicity in its relation to the education of girls has become of great importance in these modern times when that education has been so greatly prolonged. In former times, girls of the more affluent classes were taken away from school at fifteen or sixteen, and were under the guidance of the mother and the housekeeper initiated into a round of varied and useful household duties—brewing, baking, preserving, mending, knitting, &c.—which imposed no strain on intellect, and but little ruffling of emotion. But nowadays the work that was done by the daughters of the house is done by servants or in shops and manufactories, and the daughters of the house are expected instead to devote themselves to the acquirement of knowledge and accomplishments till they are eighteen or nineteen years of age, or at least for several years during which their periodic functions are going on. Now even from a medical point of view there is a good deal to commend in the higher education of women, for occupation of some kind is needful to save them from that dreary, aimless vacuity of mind that is hysteria's favourite soil; and if practical employments are not open to them in the interval between girlhood and marriage they had better study than sit idle. But the great point is to see that they study wisely, and there is reason to fear that they do not always do so, but that, forgetful of the peculiarities of their organisation, they often study continuously like the other sex, and so induce depression, exhaustion, and irritability, and lay the foundation of many nervous derangements and occasionally of mortal diseases. The late earnest and scholarly Dr. Edward H. Clarke, of Boston, U.S.A., collected a large amount of testimony bearing on the effects on health of the higher education of women in America, where it is often pushed with a remorseless eagerness as yet but little known in this country. And all the testimony collected by Dr. Clarke is in favour of one conclusion: that severe brain work for girls, kept up continuously, is most injurious to health, and that its disastrous consequences are most frequently and ostensibly exhibited in the nervous system. A teacher of experience, in laying his opinion before the State Board of Health of Massachusetts, which, in 1874, instituted inquiries on the subject, says, "At certain periods I think that study with girls should wholly cease for some days. I refer to girls from twelve to twenty years of age. Any-one who has taught boys and girls—in separate schools I mean—must have noticed the greater proportionate irregularity of attendance of the latter, and as a parent he would know the reason and the necessity of cessation from work." Another teacher, also well qualified to judge, observes, "Could the custom of keeping girls between the ages of thirteen and nineteen out of school and at moderate rest during certain periods become established among us, a certain number might suffer restraint not absolutely demanded, but the general result would be an incalculable gain to the health, present and prospective, of the inhabitants of this Commonwealth." "Common sense and the teachings of physiology," says Dr. da Costa, of New York, "point in the direction of lessening, as far as practicable, work at a time when the whole system is depressed, and, as regards the effect of mental strain, I saw, some years since, a case of violent delirium lasting several days produced in an ambitious school-girl busily preparing for her examination." The evil effects to be charged to wrong methods of education of women in America are, according to the witnesses, numerous and deplorable. Dr. Fordyce Baker intimates that few women who as girls have been submitted to these methods are able to nurse their children, and are thus deprived of a needed stimulus, and rendered liable to many disorders which are likely to enfeeble their constitution. The Principal of the New York State Normal School, Dr. Cohran, thus expresses himself: "I have been compelled to the conclusion that the sexes cannot be educated on the same system with advantage, and that the physical disadvantages under which the female labours render it necessary that a system be devised so elastic, with so much optional work, that the female may rest at least comparatively as the occasion requires." Professor Loomis, of Yale College, after describing the ability of girls in the study of mathematics, and the intesity of interest of his own pupils in the mathematical examinations which sometimes reached such a pitch that it was "necessary to allay the excitement of the throbbing brain by putting bandages of ice on the temples of the competitors," goes on to express his repentance for such proceedings, and intimates that he has abolished medals, public examinations, and all unnecessary stimulants to the mental discipline of girls. Looking at the increasing physical deterioration of American girls, he says, "The cry to our older colleges and time-honoured universities is: Open your doors that the fairer part of creation may enter and join in the mental toil and tournament! God save our American people from such a misfortune!"

A piteous but instructive story, which should be put in the hands of all the fanatical advocates of the higher education of women, is told in a letter addressed to Dr. Clarke by the mother of a girl who unquestionably fell a victim to the curriculum of study in a school of the highest character. She entered the school at fifteen years of age, a fine, healthy girl, with a broad chest, well-developed muscles, and quick wits, and this is the sort of discipline she was subjected to. One hour a day was allowed for walking and recreation, and half of that could be spent in the music room if desired; the rest of the day was given up to study, and every conceivable incentive to mental effort was supplied; examinations took place from time to time, and at one of these she was seated at a table, without books, ceaselessly thinking and writing from 10 a.m. till 8 p.m. Of course her mother soon began to notice drooping; her complexion became transparent, and she complained of feeling "so tired." She had tonics administered; she had chills and sickness, and looked frail and like a withered flower; but of course her gratified parents and her own emulation urged her on to still greater efforts. Ruthlessly was this poor girl kept at work through all the stages of Bright's disease, literally dying by inches at her desk, and only leaving off school toil two months before the end came. Of course her parents were disconsolate, and recognised too late that she was the victim of a want of sense in education.

Fortunately English girls are not yet subjected to educational processes so atrocious as those that have been alluded to, and fortunately, also, they enter upon the educational course with constitutions better prepared than those of their American sisters to resist the pernicious influence of educational pressure. Inheriting less etherial but more serviceable bodies than American girls, they pass a tranquil childhood, and are imbued with a love of fresh air and exercise, and with notions as to their own destiny, and as to the advisability of having regular and substantial meals, which American girls would consider somewhat coarse or unspiritual. But the tendency is in certain social sects, at any rate, to sacrifice the English firmness of frame and plumpness of form to elegant limpness and æsthetic attenuation, and to protract and augment educational pressure; to forget that there are physical and mental differences in boys and girls: differences radical and all-pervading, which make it wasteful foolishness to attempt to educate both in the same way and for the same ends. Already we hear in England of distinguished girl graduates being incapacitated for work by brain exhaustion and bodily infirmities, similar to those which have been alluded to as afflicting American girls devoted to intellectual work; nay, more than this, we hear of many exceptionally well-educated and clever girls sinking into pulmonary consumption. It may be that in cases of the latter kind the intellectual vivacity, which so often accompanies incipient phthisis, has guided to the excessive study; but it may be also that the excessive study has induced the phthisis, and few physicians will doubt that if female education is to be carried on between the ages of fourteen and twenty without careful adaptation to the requirements of the female organisation, we shall have many cases of pulmonary degeneration directly or indirectly resulting from it.

Active muscular work may be carried on continuously in young women with less detriment than brain work; that is to say, if plenty of fresh air and nourishing food be supplied. Thus girls engaged in out-door occupations follow them uninterruptedly for years without inconvenience, and a well-known trainer of gymnasts, who has had a medical education, states as the result of his inquiries that female athletes as a rule enjoy excellent health. Continuous application, however, to sedentary occupations, as in the case of sempstresses, to labour in factories, and to fatiguing employments like those of shopwomen, who have to stand for many hours daily, leads to ill-health, and the Massachusetts Board, which has investigated this question also, concludes that certain requirements should receive full recognition in the employment of labour as affecting women.

SEASONAL CHANGES.

The influence of the seasons on human development, activity and health has not yet been studied with the care which, considering the patent and universal effects of that influence on animal and vegetable life, we might have expected would have been bestowed on it. The weather is the commonest topic of conversation, and millions of observations are made daily on the bearing of weather changes on bodily comfort and the progress of disease; but these observations are scattered and useless, and it is only quite recently that a systematic attempt has been made to ascertain the true relations of weather, and of season, which is weather "long drawn out," to the prevalence and mortality of disease. The arts of civilisation have seemingly made man more and more independent of those seasonal variations which are of such momentous interest to the lower creatures, and in the absence of the more conspicuous and superficial results of those changes he has ceased to note a deeper dominion which they still exert over him. The custom of being bled at spring and fall, the last surviving recognition of a community of annual variation with the birds that moult, and the trees that bud and cast off their leaves, went out of fashion half a century ago, and the majority of healthy people are now unconscious of any alterations in their own feelings or condition corresponding with the rotation of the seasons. And yet it is certain that the seasons have still a powerful hold upon the human organism, no matter how artificial the circumstances may be in which it is placed, or what precautions are taken to exclude their influence. There is a gain of body weight in winter and a loss in summer, and vital statistics show that each season has diseases which may be called peculiarly its own. But there is just one seasonal change that is of special interest in connection with education and mental evolution, and that is the erethism or excitement of the nervous system that corresponds with the return of spring. This had been almost lost sight of, and Tennyson's assertion that—

> "In the Spring a livelier iris changes on the burnished dove;
> In the Spring a young man's fancy lightly turns to thoughts of love,"

was looked on as a poetic fancy rather than the statement of a scientific truth. And yet it would seem that it is absolutely true that there is in human beings, with the return of spring, an increase of vital activity in the nerve centres akin to the vernal excitement in the lower animals, which is in them principally manifested through their sexual and reproductive functions. The highest birth-rate in this country is reached in the quarter ending the last day of March, or nine months subsequent to the annual resuscitation of vital energy, while it is during and immediately after that resuscitation, which, like all rapid physiological changes, brings with it pathological risks to the structures and tissues involved, that nervous diseases are most prevalent. Dr. Mitchell and Mr. Buchan, by their masterly examination of the meteorological and vital statistics of London, have proved that while the general preponderance of deaths falls in the cold months of the year, when bronchitis and pneumonia, which are together responsible for one-fifth of all deaths in the metropolis, and other diseases of the respiratory apparatus most abound, the preponderance of deaths due to nervous diseases is in March, April, and May. Cephalitis, under which a variety of forms of inflammation of the brain and its membranes are included, has its minimum as a cause of death during September, October, and November, and is above its average from the beginning of the year till the end of August; its maximum period being from the middle of February till the end of May. Epilepsy has its minimum death-rate from the middle of July to the first week of September, and its absolute maximum in March and April. And chorea, or St. Vitus's dance, has its maximum death-rate from the middle of February to the middle of June; its minimum from the middle of August to the middle of December. In close accord with these conclusions of Dr. Mitchell and Mr. Buchan is the information to be derived from the reports of lunatic hospitals, which show that the mortality amongst the insane is greatest, and that the admissions into these institutions are most numerous, in the spring months, when all purely nervous diseases are most fatal and prevalent. And so, too, suicide, which on the large scale may be taken to represent a profound and violent disturbance of the nervous system, is, like nervous and mental diseases, subject to the influence of the periodic changes in the astronomical conditions of the earth, and above all to the variations in temperature, humidity, and barometric pressure which constitute climate. In all the countries of Europe, as Mosselli, elaborately confirming a previously well-known fact, has demonstrated, suicides increase in frequency in those spring months when there is an upheaval in the nerve centres, and when the passions,

> "Exulting, trembling, raging, fainting,
> Possessed beyond the Muse's painting,"

throng round "the magic cell" not of the heavenly maid, but of the vesicular neurine of the brain. The number of voluntary deaths goes on increasing from the beginning of the year to June, in which month it attains its maximum and thence falls with regularity to the end of the year, the minimum falling in November and December, at the very time when the *à priori* philosophers like Montesquie had fixed the maximum. The statistics of crime, again like those of suicide, bear marks of the influence of the seasons on human nature, for they reveal that crimes against the person are most numerous in spring and early summer, when the stag's horns are budding and his aggressive instincts are most pronounced; while crimes against property are most numerous in autumn and early winter, when squirrels lay by their stores.

But it might be said, all the instances of seasonal changes adduced have reference to adults, in whom those functions which have, at least in one sex, a marked periodicity, have been established, and they give no warrant therefore for inferring that children are affected by seasonal variations. To this it may be replied that the same laws which regulate the annual fluctuations in the prevalance of the conditions alluded to in adults may be traced out in the diseases of children. Convulsions, from which so many infants and children perish, have their minimum death-rate in September and October, their maximum in February and March; and hydrocephalus has its absolute minimum in September and October, its absolute maximum in March and April. Whooping-cough, in which a spasmodic element is prominent, and which is really more a disease of the nervous system than of the respiratory organs, has its maximum mortality in the spring months, and it is instructive to note that scarlatina, which is certainly independent of changes in the nervous system, is most fatal just when whooping-cough is least so. Not only, however, are the strictly nervous diseases of children most active in spring, but another class of diseases from which they suffer greatly, and which in some way not yet elucidated are related to nervous diseases, are then also most energetic. These are diseases of a tubercular and scrofulous nature. Consumption—one of the two most fatal scourges of our British climate—has its mortality distributed through the several months of the year in a manner identical with that of the mortality from nervous diseases; and the mortality from teething, under which are included many scrofulous complaints, follows a course throughout the year exactly corresponding with that of the mortality from convulsions.

No one can study the distribution throughout the year of the various diseases which are fatal to children without being struck by the lethal activity of those directly or indirectly involving the nervous system in the spring and early summer, and no physiologist can view this fact, in connection with biological science generally, without feeling assured that the nervous system in the young is in some way powerfully affected at that season, and is undergoing active evolutional changes. And the vernal disturbance of the nervous system is manifested in other ways than by its liability to serious disorder, as sharp-sighted parents and teachers may often observe for themselves. There come with spring in many children a restlessness and excitability, a perversity and irascibility of temper, or a listlessness and indisposition for exertion that are not displayed at other times; and there come then, also, more plentifully than at other seasons, physical indications of debility and the scrofulous habit, such as enlarged glands and tonsils, dyspepsia and loss of appetite, strumous ophthalmia, discharges from the ear, and enlargements of joints. Could statistics bearing on the subject be obtained it would certainly be established that a far larger proportion break down under educational processes during spring than at other seasons. Nay! it would scarcely be rash to assert, that when systematic measurements of the head are made regularly, at all stages of growth, it will be found that the head expands more rapidly and decidedly during spring and summer than during autumn and winter. One significant fact, showing the greater activity of tissue-growth in spring and summer, has been established by Berthold, who has found that the same finger-nail which in winter required 152 days for its complete regeneration, in summer required only 116 days. The embryological relations of the skin and nervous system should not be overlooked in connection with this fact.

The practical deduction from all this as regards education would seem to be that spring is the time when there should be a relaxation of pressure on the higher nerve centres of children, when more rest and less work should be enjoined, when strong stimulation and severe exercise should be carefully avoided. But in this, as in so many other educational matters, physiological indications have been not only disregarded but contravened, for in most schools the hardest work of the year is reserved for this perilous season. Examinations, which are generally held at the end of the summer term, have to be prepared for, and so special diligence and concentration are demanded, and both pupil and teacher often feel the injurious effects of over-exertion. An American author has noted this. He says, " In spring a certain languor is felt by many perfectly sound persons. It is then that the work of the year approaches its climax, and the entire school for two months is conscious of a moral spur to increased effort. The yearly examination at the close of June requires additional exertion in preparing papers, correcting, marking, averaging, and in making ready for public exhibitions." Education, judiciously conducted, may go on safely in spring as in other seasons, but there should be no extra labour nor competitive excitement then, while for fragile, mobile, and scrofulous children there should be an abatement of the tasks exacted from them in winter. The example of Mr. Coller, of the Roxbury Latin School, merits imitation. He made it a rule for his teachers to lessen the school work whenever the warm weather set in. Had Milton some obscure notion of the same kind in his mind when he said, while sketching out his scheme of education, " In those vernal seasons of the year when the air is calm and pleasant, it were an injury and sullenness against nature not to go out and see her riches, and partake in her rejoicing with heaven and earth"? At this vernal season certainly a liberal allowance of out-door exercise and communion with external nature is needful to health or vigour. Examinations will be least apt to damage the nervous system if taken immediately before the Christmas vacation.

When children, during early spring or summer, exhibit very marked excitement or prostration, or are attacked by any of those trifling ailments which are often neglected, but which are very significant, such as swollen tonsils or glands, the work of education should be interrupted. The way in which such delicate children revive and strengthen when sent for a rest at the seaside or to a seaside school, where they are treated as half invalids, is surprising, more especially when they have abundance of fresh air and of sunlight, which is indispensable to nervous and delicate children, as to all growing organisms, promoting, as it does, the chemical changes that are essential to health and comfort. It is for such children that school-ships are to be desired. To them a genuine ocean climate—the invigorating atmosphere that is to be found at a distance of not less than thirty miles from land—is more likely to prove beneficial than the mixed air of our coasts, beneficial in its way although that be. The experience of innumerable invalids who take long voyages in search of restorative influences puts it beyond doubt that ocean life does work remedial and bracing effects that are not otherwise to be secured. The entire change of scene, the facilities afforded for being much in the open air and in sunlight, the habitual respiration, when on deck, of air free from organic and inorganic impurities, such as floating particles of dust and carbon, but saturated with saline constituents, together with the sedative action of a comparatively humid atmosphere and high barometric pressure, and the tonic effects of sea-breezes and of changes of climate in passing through different latitudes, exert marvellous effects in arresting certain maladies and in imparting vigour. These benefits might readily be obtained for children of the tendencies indicated as well as for those who are threatened with phthisis, or who are recovering from pneumonia or pleurisy, joint and nervous affections, while at the same time education, which, in these struggling days, parents are always reluctant to forego, might still be carried on in a moderate degree. Were an approved and commodious ship fitted up in a suitable manner, and officered not only with a navigating contingent, but with a doctor of experience and character, ranking next the captain, with teachers of ability and judgment, and with competent matrons and nurses, an opportunity would be afforded of sending delicate children on sea-voyages from which they would reap incalculable advantage, especially in the spring and summer seasons.

EPOCHAL CHANGES.

Besides the rhythmical changes in the bodily functions, which have been already dealt with, there are other marked periods of modification of these functions, which, as they occur at wide intervals, are the boundaries of different phases of existence, and are dissimilar to each other in their characteristics, may be called epochal, but which may yet perhaps be brought under a general law of periodicity with a term of seven years. The first epochal change, the primary dentition, occurs during the first year of extra-uterine life, while at the seventh year of life, the second dentition, that is to say the second epochal change, is in progress. At fourteen years of age comes the revolutionising epoch of puberty; at twenty-one the epoch of transition from adolescence to manhood (the third dentition some would designate it, for the wisdom teeth ought to appear about this time), and at twenty-eight the epoch of maturity, or the attainment of perfection of the physical and mental powers. At the sixth or seventh septennial period women reach the grand climacteric, and at sixty-three, it has been maintained, men undergo changes which are analogous to the climacteric in women, losing flesh, becoming weak, nervous, dyspeptic, and low-spirited for a time, after which they either recover health or pass through some decided form of disease. This division of life into septennial periods may appear fanciful to some, but at any rate no doubt can be felt about the epochal changes, limiting the first two septennial periods; and it is with these—with the two dentitions and puberty—that those interested in education and the healthy growth of the nervous system are concerned.

The first dentition commences with the appearance of the two central incisors of the lower jaw at about the seventh month of life, and terminates with the appearance of the second molar teeth at about two years of age, the other teeth appearing in this order—the central incisors of the upper jaw, the lateral incisors of the lower and of the upper jaw, the first molars, and the canines. The eruption of the teeth may take place without any constitutional disturbance or ailment, many infantile maladies which were formerly attributed to it being now known to be due to improper feeding and the neglect of hygiene; but while this truth is recognised, it must not be allowed to conduct to another error—that of ignoring altogether the pathological relations of teething. The eruption of the teeth is always attended with vascular turgescence round the bulbs, and up to a certain point that turgescence is physiological, but beyond that point it becomes actual inflammation, and causes tenderness, pain, fretfulness, and more or less abstinence from food. Now the nervous centres in the infant are undergoing rapid development, and are very impressionable, and if to the ordinary impressionability of the period of growth there be superadded the impressionability and liability to sudden excessive discharge, which come from inherited neurotic tendencies, it is not unlikely that the irritation of the twigs of the dental branches of the fifth nerves will bring on convulsions. These nerves, the fifth pair which are distributed to the skin of the head and face, the mucous membrane of the mouth and throat, the glands for tears and saliva, the muscles of mastication, &c., are much larger in infancy relatively to the size of the nerve centres than they are in adult life, and in that respect resemble the same nerves in many of the lower animals, and probably play a more important part in the economy than they afterwards do. Irritation of these nerves, or rather of their branches in the cheeks where there has been injury of the nerve centres, has been shown by Brown Séquard to be a sure way of inducing epileptic fits in guinea-pigs, and so it can be readily understood how involvement of branches of these nerves in an inflammatory process may bring on convulsions and other nervous diseases in infants. Feinberg has produced inflammation of the spinal cord in rabbits by playing for half an hour with ether spray on the hind legs, which were shaved. The animals thus treated were at once paralysed, then recovered, but ultimately died of softening of the cord, and the same result was produced by cauterising the large nerve of the hind limb. Feinberg's experiments showed that irritation of nerves on the surface may produce inflammation of nerve centres without inflammation of intervening structures, by the effect of that irritation on the blood-vessels, first contracting, then dilating them through their special nerves; and they suggest how patches of inflammation may be produced in the brains or cords of infants by the local irritation of dentition when that is acute or unduly prolonged. Infants who are burned or scalded, that is to say whose cutaneous nerves are cauterised even over a small surface, are peculiarly liable to convulsions. Dr. West teaches that cerebral congestion is frequent during febrile disturbance in infants, and that the liability to cerebral congestion imparts a special gravity to all ordinary maladies occurring at the time.

Teething caused 4,256 deaths in England and Wales in 1879, the last year for which returns are available, and these deaths were distributed between the two sexes and amongst the different months of the year exactly as nervous diseases are distributed, and hence it may be inferred that where teething is fatal it is so principally through the induction of disorders of the nerve centres. Obviously so large a mortality from teething indicates an enormous prevalence of nervous disorders caused by it—disorders which, although not fatal, still often leave permanent traces behind. Many cases of idiocy and imbecility date from convulsions at teething, and it is common to discover a history of these in grown-up persons complaining of nervous affections. A large percentage of adult epileptics prove on inquiry to have had convulsions when teething. If one child in a large family has suffered from them, he or she is constantly seen to grow up more capricious in disposition or weaker in capacity than the other children, and indeed it may be taken as certain that severe convulsions during teething leave permanent morbid vestiges behind them in a large proportion of cases. And there is another disease, generally commencing during the first dentition, which cannot be overlooked here, because a deficiency of intellect is one of its most inevitable consequences. That disease is rickets. When a teething infant ceases to play, and lies with outstretched limbs, showing signs of pain during lifting or moving, when it is perpetually kicking off the bed clothes, as if in the endeavour to cool itself, when it suffers from profuse perspirations of the head and neck, when its face grows broad and square, and assumes an aged, anxious look, the fear of rickets should be awakened, even although there be no deformity, and measures should be taken accordingly. The probability is that the limbs will shortly become crooked, the spine bent, the muscles wasted, while the teeth are retarded in their development, unless skilful feeding, combined with active medical treatment, prevails to arrest the progress of the disease. It ought always to be a subject of congratulation to parents when the first dentition has been got safely over.

The precautions to be taken to protect the nervous system from mischief during teething are mostly to be drawn from the rules for the general management of infancy. Special vigilance must be exercised when the infant begins to be peevish, while saliva dribbles from its mouth, and the gums grow hot. Diet must be simple and regular, overfeeding must be avoided, abundant exercise in the open air provided, and tepid bathing, which greatly allays nervous irritability, perseveringly carried out. Scarification of the gums is no longer a routine practice, as it used to be, as it does not really release the tooth nor remove the pressure on the nerves, and the number of cases of excessive local inflammation in which it can be usefully resorted to is really very small. When convulsions have actually occurred, however, scarification should not be overlooked as a possible means of giving aid. A number of drugs have been introduced into use in recent years which have rendered teething a much less formidable epoch of infant life than it was formerly, by enabling a skilful medical man at once to arrest some of its most dangerous symptoms.

The second dentition, which begins about the seventh year with the appearance of the first permanent beyond the secondary temporary molar, and extends to the eleventh or twelth, when the canines and second permanent molars are cut, produces more constitutional disturbance than is usually supposed. Rengger observed that young monkeys often sickened and died of fever when shedding their milk teeth, and the same process is certainly not free from risk in the human subject. Nervous children occasionally become emaciated during its progress, or suffer much from neuralgia or cough ; and from having been hardy and robust, they become pale and delicate. Apparently in connection with it also complaints are sometimes made of headaches, tenderness of the eyes, and lassitude. At this period also is encountered that curious and sometimes puzzling perversion of the moral nature known as malingering. From egotism, and insatiable craving for notice and sympathy, from a desire to escape work, from jealousy, or from some more complex motive, the boy or girl simulates disease, and may do so with considerable ingenuity and success, or grossly exaggerates some trifling ailment. Where thorough-going malingering is practiced, the disease adopted is generally one of which an instance has previously occurred in the household, and which the child has therefore had an opportunity of studying; and when this disease is one that is of an hereditary nature, there is of course a presumption in favour of the genuineness of the assumed illness, especially at its outset. Great anxiety was caused for a time by a boy whose brother had died of acute hydrocephalus, and who complained of headache and giddiness and deliberately squinted; while a girl of eleven deceived even her doctor for a day or two into the belief that she had some disease of the stomach by persistent self-induced vomiting after each meal. Hydrophobia has been simulated by a malingering girl who had heard a description of it read. A malingering child, although a malingerer, is never quite healthy, and always requires medical treatment and guidance. The disorder is generally poverty of the blood and nervousness, which not rarely are connected with constitutional changes associated with the second dentition. Dr. Jackson says, referring to the disorders incidental to the second dentition, "The remedies which I have found most useful are as follows: First, a relief from study or from regular tasks, yet using books as far as they afford agreeable occupation or amusement. Second, exercise in the open air, preferring the mode most agreeable to the patient, and in more grave cases the removal from town to country."

Incontestably the most remarkable and momentous epoch in the life of a human being is puberty, when rapid growth takes place, when new physical characteristics are assumed, when powers previously potential become active, and when the two sexes diverge more widely than hitherto in bodily configuration and mental traits. This epoch occurs in the male in this country at from fourteen to sixteen years of age, and in the female a little earlier—from the thirteenth to the sixteenth year.

A very rapid body growth precedes puberty in both sexes, and this comes a year or two earlier in girls than in boys. It has been argued that it is to the greater or less development of the frame at this era that the final difference in the height of individuals is chiefly to be attributed, and hence the influences which then encourage or retard growth are deserving of study. All the changes connected with puberty are more rapid in the girl than in the boy. The girl almost at once becomes a woman, but the boy is still a boy for several years after puberty, and only very gradually attains to manhood. Dr. Roberts' tables of heights of boys "show that the pre-pubertic growth begins about the age of twelve and a half or thirteen years in the non-labouring class, and causes not only a higher mean, but a wider range between the tallest and shortest boys than among the labouring class, amongst whom the pre-pubertic growth does not show itself till a year or two later." A comparison of the heights of boys of the non-labouring with those of boys of the artisan class from the age of twelve to seventeen makes very conspicuous the effects of social circumstances on corporeal development. Occasionally the pubertic body growth goes on with marvellous quickness. Mr. Power alleges that among the Nogi tribe of Californian Indians the children remain mere dwarfs till they are twelve or fifteen years old, when they start growing and shoot up suddenly—eighteen inches or so. Spurts of hasty and great growth are seen in this country chiefly in children of certain diatheses—the catarrhal, for example, and the strumous—and such spurts both betoken and aggravate constitutional weakness.

The changes that take place in the nervous centres at this time of life have not yet been differentiated. That great changes do take place then is certain, but what they are cannot be particularised. Expansion of the skull, which may be received as an index of increase in size of the brain, still goes on; but we have no observations showing either that it goes on at an augmented rate before, during, or after puberty, or that it takes place more particularly in certain regions. The nerve centre changes peculiar to the period are perhaps more of the nature of higher elaboration than of mere increase in bulk, and it may be surmised that while all the higher centres receive a nutritive impulse and extend their cell connections, a special multiplication of elements and differentiation of structure take place in the lumbar swelling of the spinal cord, and in the convolutions of the brain which connect the lower and inner part of the temporo-spenoidal with the occipital lobes, and are in contiguity to the centres of smell and tactile sensation. This, at any rate, is indubitable: that great changes of some kind must take place in the brain at a period when signal and far-reaching alterations are wrought in intellect and character; for at puberty the boy or girl becomes susceptible to impressions of a new class, and to emotions of a new order, which colour all subsequent existence and develop new phases of mental activity.

An epoch when such important and rapid changes as those just indicated in mind, brain, and body generally, are going on must, of course, be fraught with danger to health. The nerve centres become unstable. Insanity, which before puberty is rare, after it becomes common; and a large proportion of cases of epilepsy date from that period. From an analysis of 1,450 cases of epilepsy, Dr. Gowers concludes that more than one quarter, or 29 per cent., commenced under ten years of age, and nearly one-half, or 46 per cent., between ten and twenty. "A large number of cases, no less than 12½ per cent. of the whole, commenced during the first three years of life. In this group no case of simple infantile convulsions are included, only such as beginning in infancy continued as chronic epilepsy. The number of cases is largest in the first year (5½ per cent. of the whole), and falls rapidly to three years of age, and then more slowly until five, when the minimum for the early period of life occurs—only 1·7 per cent. commencing then. From this there is a considerable rise at seven—the commencement of the second dentition; then a fall at eight, and from this the number increases slowly at nine and ten, rapidly at twelve, until the maximum is reached at fifteen and sixteen, at each of which 84 cases commenced—5¾ per cent. of the total number."

Hysteria originates at the period of puberty in even a larger proportion of cases than does epilepsy, more than one-half of the cases collected by Briquet—1,000 in number—having begun between twelve and twenty years of age. Strong emotional disturbance occurring at this time—such as jealousy, disappointment, or anger—acting on the appropriate temperament, may induce it in any of its protean forms, from a mere rising in the throat and a few tears, up to the most violent paroxysms of convulsion. Hysterical manifestations, however, are seen now and then in children of both sexes under ten years of age, and not unfrequently in boys from ten to fourteen. In them emotional perturbation of some kind is generally at work, or the same morbid craving for notice and sympathy which at a younger age leads to deliberate malingering. In girls, hysteria is often to be ascribed to a capricious bringing-up, alternate petting and thwarting; to a mis-directed education, which has conferred no discipline and set up no high aims; or to the mere sickening vapidity of fashionable life, with the selfishness or self-analysis to which it conduces. It would take many pages to describe the symptoms of hysteria—which are, indeed, so kaleidoscopic as almost to baffle description. It may be briefly stated, however, that during the paroxysm there may be giddiness, blindness, rhythmic twitchings, suffocative spasms, histrionic grimaces, cataleptic rigidity, screaming, general convulsions, with loss of consciousness more or less real; and that in the intervals between the paroxysms there may be loss or impairment of any of the senses, neuralgia, spinal tenderness, paralysis—partial or complete—of any limb or limbs, contractions of muscles, loss of voice, flushings, pallors, perspirations, high temperatures, vomiting, total abstinence from food, derangement or suppression of secretions, &c., always with mental and moral perversion, more or less pronounced, and exhibited in egotism, lying, systematic deception, delusions, morbid appetites, or actual mania or melancholia. These symptoms may perhaps be ascribed primarily to increased irritability of the cells and fibres of the brain in the neighbourhood of a body called the optic thalamus, and the different varieties of hysteria may be explained by different degrees and different areas of distribution of this irritation. The management of hysteria is a medical question demanding of the physician not only professional skill, but the utmost firmness and fertility of resource. This may be said, however, that medicinal agents are useless in the treatment of it without judicious moral control. Powerful appeals to the imagination are not without their utility, but the best thing that can happen to any hysterical girl is to be brought under the domination of a strong will and kind heart. Cases of hysteria are, as a rule, best treated away from home—in a hospital or doctor's house. Except in severe cases education need not be interrupted, but it ought to be well directed and combined with useful employment. Where there is a predisposition to hysteria, a training in self-renunciation and a good moral education generally, with great temperance in amusements or pursuits that stimulate the emotions, will often ward off this distressing, humiliating, and often long-protracted disease.

But where no hysteria nor other nervous disease is developed, there is not seldom at the epoch of puberty a condition of nervous exhaustion and excitability, with bodily weakness, that ought to receive the attention of educators. Of 141 teachers to whom the Massachusetts Board of Health put the question—Does the advent of puberty increase the liability to suffer from attendance at school? 120 replied, Yes—a large number of these adding that the liability thus to suffer was especially marked in the case of girls. This points to the necessity of great caution in conducting the school-work of girls at this period, and to the propriety of reducing it in many cases when the first signs of puberty are apparent, for it is to be remarked that in all great epochal changes in the human organism the pathological risks seem to lie mostly at the outset of the process. When it is once fairly initiated it goes on with less risk.

Boys at about fourteen years of age are apt to drop into a habit that is then deleterious—namely, the habit of smoking. Whatever differences of opinion there may be as to the effects of smoking, physicans will agree that it is injurious before eighteen or twenty years of age. Nicotine, the active principle of tobacco, which is taken into the system during smoking, first excites and then depresses the heart's action, and slows the respiration. A small quantity augments the secretion of the gastric juice, and so increases appetite, while it also produces a certain degree of cerebral excitation and facilitates mental work; but an excess, and the smallest amount is an excess to the young, causes sluggishness in the voluntary muscles, mental irritability, dizziness, neuralgia, and also—and this makes it exceedingly pernicious at puberty—excites the feelings. It is not unlikely that smoking stunts growth. The habit ought to be invariably discountenanced in boys and youths. The cigarette smoking of girls is a freak, and not a habit, and is best ignored.

PHYSICAL EDUCATION.

The value of physical education does not now require to be vindicated. It is generally recognised that "to be a good animal" is one of the first requisites to success in life; and that as man is subject to the same organic laws as the inferior creatures, he must, like them, be judiciously fed and trained if he is to attain to the full measure of his vital powers. The subjects of feeding and training, however, in their relations to health generally being treated in another section of this work, it is only necessary here to refer to certain points in which they have a special relation to the development and well-being of the nervous system.

Exercise.—All life is energising or taking exercise, absolute rest being found only in death. All health is energising or taking exercise in a vigorous and harmonious way. All disease is energising or taking exercise in a weakly and disorderly way. And as health is essential to education, and exercise is essential to health, exercise has come to be regarded as essential to education, and hence schools are furnished with gymnasia and playgrounds, and children of all ages are encouraged to take part in out-door sports. But the view hitherto taken of exercise in relation to education has been far too narrow. The idea has been, and as far as it went it was a correct idea, that exercise is useful in education because it sustains and improves bodily health by expanding the lungs, quickening the circulation, shaking the viscera, and promoting growth in the muscles and bones. But we now know that besides doing all these things, exercise may be made to contribute to brain growth, and to the symmetrical development of the mental faculties. In all muscular movements there is action and reaction. When a movement is willed a current is sent forth from the brain, and the muscle contracts. But that is not all: the instant that the muscle contracts the sensory nerves take up the tale, and accurate reports are conveyed to the brain of all that is going on at the scene of action. Nerves distributed to the muscle itself, to the skin covering it to the joint which it moves, carry back to the supreme centre precise information as to the effects of its mandate, and the information thus received is carefully registered for future guidance. For just as there is a memory of sensory impressions, of the sights we have seen and the sounds we have heard, so is there a memory of motor acts, of the movements we have performed, and of the mode in which we accomplished them. We have a sense memory and a muscle memory, and ideally revived movements form a no less important element in our mental stores and processes than ideally revived sensations. Thus the muscles not only by the locomotion which they make possible enormously widen the field from which our sense impressions are gathered, but also by the experiences which their own activities involve expand our mental resources a thousand fold. An analysis of our ideas at once reveals to us that we have few that are of purely sensory origin. It might be questioned if there are any objects that are known to us by their sensory characters alone. "Our ideas of form are not mere revived optical impressions which are properly limited to colour, but ocular impressions combined with ideal ocular movements. Our idea of a circle is a combination of an ideal coloured outline, with an ideal circular sweep of the eyeballs; or it may be of the tactile impressions coinciding with an ideal circumduction of the arm or hand, or perhaps both these factors combined." And so it is with our ideas of weight, distance, resistance, which all involve sensory and muscular factors, and to revive in memory any such ideas is to revive both the sensory and motor elements of their composition, and to repeat faintly in certain nerve centres the processes which corresponded with certain motor acts. Ideas, therefore, of almost all kinds involve a re-excitation of motor as well as of sensory centres; and while it cannot be said that complex ideas have any fixed habitation in the brain, it is clear that they involve the activity of those motor areas which we have referred to as being situated in the middle brain. Electrical stimulation of those centres, it will be remembered, results in definite movements. But the same movements can be produced by the excitation of points lower down in the nervous system. The cerebral hemispheres, however, are undoubtedly the seats of conscious mental activity, and hence there are the best grounds for believing that the points in the hemispheres from the stimulation of which these movements result are the centres in which they are represented in consciousness, and are in fact the centres of motor ideation.

Now, the centres of motor ideation require to be exercised in order that they may be properly developed, and may contribute usefully to mental processes, and hence muscular training is likely to assume a more important and precise place in our educational systems of the future than it has hitherto done. The muscles are dependent upon exercise for their growth and health. If they are altogether disused, as in some forms of paralysis, they undergo degeneration and waste away. If they are insufficiently exercised they dwindle and become attenuated and weak. If they are well used they grow large and strong. And the same is true of the nerves that supply the muscles. If they are disused, as in paralysis, they waste and undergo fatty-degeneration. If they are insufficiently used they become atrophied and feeble. If they are well used they are plump and vigorous. And the same is true again of the nerve centres with which these nerves are connected. The whole of them, in series from the spinal-cord upwards, are only thoroughly sound when they are well used; and as regards the motor centres, it can only be said that they are well used when the muscles with which they are in relation are well used also. We thus see that an extensive region of the brain, in which the motor centres are situated, and which is of course in intimate communication with all the other regions of the brain, can only be fully vigorous when the whole muscular system is fully vigorous also; and we recognise that good muscle work is essential to good brain work.

But exercise, besides being essential to the maintenance of nerve centres in health, has very special relations to their development and growth. The various centres which make up the encephalon, or whole mass of nerve substance within the skull, attain their functional activity at different epochs and are perfected at different rates. The senses, the motor powers, the emotions, the intellectual faculties, do not come all at once, nor drop in fortuitously now and again; they present themselves in a definite succession, and with a strict regard to evolutional precedence, in the infant, the child, and the youth, from the most simple reflex acts to the supreme efforts of will. Each centre emerges from its "antenatal gloom" at an appointed time, and each has a certain season prescribed to it in which to perfect its functions. Reflex centres that have been long laid down, like that for the respiratory process, are at once proficient in their duty; but intellectual centres of recent evolution are only brought tardily to do their work, under the direct influence of conscious effort. And between these are innumerable centres which rise in due succession into activity, and are engaged in training for very varied periods. The foot and leg centres are in advance of those of the hand and arm in their development, and the latter again are in advance of those for the tongue and lips. Equilibrium is speedily acquired, but years are spent in mastering the niceties of speech; mastication is commenced at the ninth or tenth month of life, but writing not until several years later.

Now, in each nerve centre there are two kinds of activity, which must not be confounded with each other. There are nutrient activity and functional activity, and the rule would seem to be that these are generally in the inverse ratio of each other. When nutrient activity is at its maximum functional activity is at its minimum, and *vice versa.* When the brain of the child is growing most rapidly, its functional manifestations are not of the highest order; and when the brain of the man is doing its best work, growth may be said to be over. Growth precedes function, and yet function is, after a certain stage, essential to growth, and it is while growth and function co-exist that the opportunities for education occur. It is at the nascent period in the history of each nerve centre, when growth-activity, although becoming less energetic, is still present, and when functional activity, although still feeble, is gradually gathering strength, that most may be done to make or mar it and other centres with which it is associated. Then it is that, by suitable exercise and stimulation cautiously applied, it may be brought to the highest development of which it is capable. By skilful management this nascent period may be prolonged, and a superior anatomical substratum provided for subsequent developments; but by undue eagerness or negligence it may be curtailed or allowed to slip past unimproved.

The duration of the nascent period, as it may be called, in which growth and function go hand-in-hand, varies exceedingly in different centres. In those concerned with instinctive operations it can scarcely be said to exist, for their growth is completed without functional stimulation in the individual, and they start at once into full functional activity; but in those concerned in the higher intellectual operations it may apparently run on until late in life. But, whatever the duration of its nascent period, each centre requires extrinsic stimuli to develop its structural potentialities; and this is true of the lower reflex as well as of the higher discriminating centres. Dr. Allen Thomson hatched a number of chickens upon a carpet, and they ran about on the soft surface, and never attempted to scrape until a little gravel was sprinkled over it. The moment this was done, however, the appropriate gritty stimulus being applied to their feet and an impression conveyed to the nerve centre, vigorous scraping commenced—a proceeding in which knowledge or discrimination took no part, for the object of scraping is to find insects or seeds, and, for anything such inexperienced chickens knew, these might be lodged in the carpet as well as in the gravel.

In higher and more complex centres we may discern the influence of extrinsic stimuli, not merely in inaugurating function, but in promoting growth and sustaining structural development. Gudden, a Swiss physiologist, has shown that when the nasal organ of a young rabbit is closed, the olfactory nerve and bulb of the same side are perceptibly atrophied in six or eight weeks; and that when the eye of a young pigeon is enucleated or shut up from the light, the optic nerve and anterior prominence of the corpora quadrigemina of the same side waste very speedily. And similar consequences apparently result in the cerebral centres of the human subject when they are early cut off from functional activity, even in the higher centres; for in two remarkable cases reported by Dr. Gowers and Dr. Bastian, there co-existed with congenital absence of the left hand, and with an aborted condition of the whole of the left upper limb in two adults, an imperfect or dwarfed condition of that convolution of the brain in which the individual and combined movements of the fingers and wrist are localised by Ferrier. Now, it is clear that the growth of this convolution was stunted by the curtailment of its functional activity during its growth period. But surely we are at liberty to conclude that had its functional activity been restricted in any other way than by congenital malformation, its growth would still have been restricted. We have long known that muscles when not exercised do not develop, and we have now reason to believe that the same is true of the highest nerve centres. But muscles that have been fully developed, if cut off from exercise, waste and degenerate, which is not altogether true of the highest nerve centres; for it has been shown, in cases noted by Ferrier and others, that where a leg had been amputated in an adult who had lived many years after the operation, there was no alteration in the cerebral convolution corresponding with the limb, but only atrophy of the lumbar enlargement of the spinal cord on the same side. The lower and comparatively independent centre, with a narrow functional range, had suffered wasting; but the cortical centre in the brain, with innumerable cerebral connections, and its complex functions as a basis of motor ideation and of organic memory, had not degenerated, after the restriction of its fundamental activities by the operation.

These facts that cerebral centres never properly exercised do not develop, and that when once developed they are not so liable to waste on the withdrawal of their appropriate stimuli, or when they are cut off from their natural activities, strongly inculcate the importance of educating every centre at its nascent period, and the danger of postponing education until the nascent period is over. A large district of the brain is made up, as we have seen, of motor centres, and is concerned in motor ideas, which form a no less essential part of our mental stores than sensory ideas. The growth of that district of brain is evidently to some extent dependent on muscular exercise, and if that is withheld at the growth period the development of that district is arrested. And not only so, but that district is made up of a series of centres in relation with different groups of muscles, and each centre is dependent for its development upon the activity of its own group of muscles, and the defective exercise of any group of muscles during the growth period in its own particular centre (the growth periods in most of the motor centres having different starting-points, although overlapping in various degrees) will result in dwarfing of that centre and a corresponding hiatus, or a general weakness must exist in the whole mental fabric. From this we might deduce that swaddling bands so applied at birth as to restrain all muscular movements, and kept on during infancy and childhood, would result in idiocy—a speculation to which the wretched muscular development of most idiots and imbeciles, and the fact that their mental training is most successfully begun and carried on through muscular lessons, give some countenance. We should also have to infer that, in order to build up a sound and vigorous brain, we must insure free exercise to the different groups of muscles in the order of the development of their centres, and must in no degree interfere with the natural sequence of their evolution. That being so, we must necessarily ascertain what that natural sequence is which is to be so important a guide to education; for, in our present ignorance of it, we may unwittingly be doing much mischief. Suppose that we are encroaching on the time at which the hand centres ought to receive their most valuable education—their nascent period—and are devoting that time to the cultivation of the tongue and lip centres, then we should be impairing the full development of the brain—disturbing the balance of mind, and sacrificing that technic skill in our artisans of the future which is essential to the maintenance of our national position. For the hand-controlling centre, if not fully exercised at its nascent period, can never afterwards attain to the highest cunning; witness the clumsy caligraphy of those who learn to write in mature life, even when they practise with more than boyish assiduity, and the inferiority of the work of any craftsman who has not served a regular apprenticeship to his trade. "In these bewildered times," says Carlyle, "all education has run to tongue." But it seems that not only tongue but hand, and foot, and eye, and arm, and every muscle in the body, must be trained in due season, if education is to do what we expect of it, and result, not in headaches, and imbecilities, and nervousness, and insanity, but in well-balanced growth of body and mind. The differences which we notice between man and man in deportment, gait, and expression are but the outward and visible signs of individual variations in the development of the motor centres of the brain; and the stammerings, grimacings, twitchings, and antics which are so common and annoying alike to those who suffer and who witness them, are probably, in many instances, the effects of neglected education of some of those centres, and might have been abolished by timely drill and discipline. Of these centres, one group—presiding over the hand—ought to receive more attention than it now does amongst those who are not called upon to earn their living by manual labour. A cunning right hand is one of man's proudest possessions; and every man, no matter what his rank or fortune, would be mentally improved by learning a handicraft, and every woman should be taught to use her fingers deftly in technical work of some kind. The most learned Jews have always followed trades; and Spinoza was not only a philosopher, but a maker of spectacles. "When we begin," remarks an eloquent writer, "at all to understand the handling of any truly great executor—such as that of the three great Venetians, of Correggio, of Turner—the awe of it is something greater than that felt from the most stupendous natural scenery; for the creation of such a system as a high human intelligence, endowed with its ineffably perfect instruments of eye and hand, is a far more appalling manifestation of infinite power than the making of seas and mountains."

In connection with the hand centres, it must be mentioned that earnest appeals have been made lately for their equal education on the two sides of the brain. Modern observations have shown that in right-handed persons the power of voluntary speech is localised in a convolution called the third frontal in the left hemisphere of the brain. When this convolution is destroyed, as by the rupture of a vessel or stoppage in its blood supply, the memory of words or the power of expressing them is lost; but when the corresponding convolution in the opposite hemisphere of the brain is destroyed, speech is retained unimpaired. In left-handed persons, however, the state of matters is reversed, loss of speech occurring when the third frontal convolution on the right side is the seat of a lesion, and speech being retained unimpaired when the same convolution on the left side is destroyed. With aphasia, as this impairment of speech is called, there is almost invariably paralysis of the right hand in right-handed persons, and of the left hand in left-handed persons. These facts have led some to the conclusion that the localisation of voluntary speech on one side of the brain is due to the habit of using one hand more than the other, and to the consequent superior education of one hemisphere of the brain, from which they deduce that the training of both hands to equal skilfulness in all manipulations would practically double brain power—at least, in certain directions. They recommend, therefore, that the left hand should be diligently trained to equal expertness with the right one, and that ambidexterity, or either-handedness, should be aimed at. It would be tedious to expose the fallacies that underlie this hypothesis and recommendation. Suffice it to say that they are based on a misinterpretation of facts, and that it would be as reasonable to attempt to induce twining plants to take alternate turns instead of pursuing their natural spiral course in one direction as it is to insist on ambi-dexterity in human beings. The solar system is a very unsymmetrical arrangement. The attempt to create what is called ambi-dexterity, except to an exceedingly limited extent, must prove futile. It is no easy matter to raze out the written troubles of the brain; to obliterate its deeply engraven records is a task impossible. To undo right-handedness, we should have to alter the foundations of brain architecture laid down at a remote period, when a differentiation in the use of the two limbs first commenced. And even could we gradually retrace our steps, and by laborious efforts get rid of dextral pre-eminence, we should be working counter to true progress; for it is to be borne in mind that the two sides of the brain, which have their convolutions arranged with perfect symmetry in the lower animals, become more and more asymmetrical as we advance in the scale of being, and that they are more asymmetrical in the civilised than in the barbarous races of mankind, and in men of great intellectual attainments than in men of average mental power. And it is also to be borne in mind that dextral pre-eminence, which is only faintly foreshadowed in some of the lower animals, becomes also more and more marked as we ascend in the scale of being, and is most marked of all in those races who have brought the arts to the highest perfection. Either-handedness is never seen amongst the educated classes, but is very common among idiots, in whose training one of the great difficulties is to get them to use one hand in preference to the other in sewing, or in any manual occupation to which they may be set.

The fundamental error in the theory of either-handed education is that the left hand has been reduced to a state of inferiority to the right one. It is spoken of as a supplemental organ—as one that has lagged behind in the march of progress. Now, although for convenience it is permissible to speak of dextral pre-eminence, that phrase does not correctly describe the relationship subsisting between the two hands, which is that not of superiority and inferiority, but of difference of function. There has been a division of labour between the two, and the left hand can only be said to be inferior to the right one in the same sense that the right side of the heart might be called inferior to the left side. "As a student aiming at surgery," Professor Lister writes, "and following the precepts of Liston, I endeavoured to cultivate ambi-dexterity by holding the knife in my left hand and the fork in my right hand in cutting my meat upon a plate, and I remember being struck with the fact that the right hand was at least as awkward in the use of the fork as the left was in the use of the knife," a fact which illustrates the statement that the left hand does not merely fall behind the right one in skill, but has special work of its own to do for which it is well adapted.

For certain special purposes—such as the work of the surgeon or the feats of the gymnast—it is practicable and desirable to train the right and left hands to nearly equal expertness in certain movements; but any attempt to make them equally expert in their whole range of action, in the hope that brain-power will be thereby increased, can only cause vexation and end in disappointment. In endeavours to cure left-handedness the presumptuous limb has been bound down to the side and kept in that position for weeks, until its muscles have wasted, and yet when emancipated it has immediately resumed the leading *rôle* in all manual performances.

The practical lesson to be kept in mind in connection with muscular exercise and brain growth is that abundant and varied exercise is necessary. The desire for activity is very urgent in the young, and if it be unduly thwarted great discomfort and even illness may be produced. Every one knows how fidgetty and unhappy children become when too long confined, and how exuberantly their motor energy bursts forth when restraint is removed.

> "And four-and-twenty happy boys
> Came bounding out of school;
> There were some that ran and some that leaped,
> Like troutlets in a pool."

And it is the spontaneous activity of young children that is most conducive to healthy brain growth. Gymnastics are excellent in their way, and particularly valuable in the correction of round shoulders, a slouching gait, and various local abnormalities, but they can never be a substitute for play. Such formal muscular movements are less varied than those employed in juvenile games, and sooner induce fatigue. Then the quantity of exercise taken in gymnastics is likely to be deficient, not only because some muscles remain unexercised, but also because of the lack of sustaining interest. Even when not made repulsive by being converted into appointed tasks, gymnastics often become distasteful from the absence of amusement in them, and hence the inferiority of such artificial exercises to the natural exercises that are spontaneously indulged in. An agreeable mental excitement has a highly invigorating effect, and happiness is one of the best of tonics; and thus mere frolic is more conducive to bodily and mental well-being than formal gymnastics. That gymnastics are useful in education cannot be denied, but that the benefits derived from them are inferior to those which flow from sports and pastimes may well be argued. Gymnastics, like drill, are as much an exercise of the will as of the muscles, and thus they may be rendered serviceable in inhibiting habitual muscular movements of a disorderly character, muscular tricks, and antics, which persons of nervous temperament are apt to adopt. Most cases of stammering might be cured if taken in time by a course of throat, tongue, and lip gymnastics, and grimaces, drummings, twitchings, and contortions may be greatly mitigated by well-devised exercises. Disordered movements of the latter class, slight choreic twitchings of the muscles of the face, neck, or upper limbs, are exceedingly common at the present day, especially among girls of the more affluent classes, and are not to be disregarded, as they betray an instability of nerve tissue, with incontinent discharge of nerve force in that region of the brain in which the motor centres are situated. Dr. McLane Hamilton's recent investigations have revealed the astounding fact that over twenty per cent. of the young children of the public schools of New York are affected with choreic affections of greater or less gravity; and a few observations made in girls' high schools in this country seem to indicate that twitchings and grimaces are far more prevalent in these institutians than they ought to be.

Choreic movements, it has been said, betoken instability, or a morbid condition of certain areas of the brain, and that instability or morbid condition, while often due to a certain inherited constitution, may also be set up by emotional excitement and mental strain. There can be little doubt that choreic movements are frequently brought on, or much aggravated, in sensitive school-girls, by the pressure of their school work or the agitating conditions under which that work is carried on. Some of the centres of motor ideation, having been over-stimulated, cease to be under voluntary control, and discharge themselves irregularly and incontinently from time to time. Over-stimulation and over-exercise of these centres may alike lead to choreic movements; and the latter may also result in exhaustion and temporary paralysis, or permanent degeneration.

Mr. Frank Smith, of Sheffield, has described a disease which he calls hammer palsy, and which is observed to affect knife forgers and other hammermen. Its essential feature is a loss of power in the right limbs; sometimes limited to the right hand; but even then it must not be supposed that the palsy is due to exhaustion of the muscles or any degenerative changes in them. The loss of power is essentially a palsy; and its distribution, as well as the fact that impairments of speech are often associated with it, clearly show that it must be traced to the nerve centres which animate and direct the muscles involved. A pen-knife forger frequently delivers as many as 28,800 accurate strokes with his hammer in a day, and the rapidity and precision with which the blows descend upon the slender piece of iron are wonderful to behold. Supposing him to work three hundred days in a year, and to continue this for ten years, he will, in that time, have delivered more than eighty-six million strokes, and just so many discharges of nerve-force must have occurred in the group of nerve-cells presiding over the muscles employed, and in those other groups which calculate the distance and judge of the amount of force necessary to be liberated at each blow. Little wonder that these cells sometimes suffer from the effects of wear and tear, and degenerate. The excessive demands made upon them are at first resented by a sense of weariness; but this is for a time ignored, and afterwards abolished, and the strain is long kept up with apparent impunity. But the inevitable breakdown comes at last, in those at least whose nerve-tissue is of a fragile texture. The breakdown in hammermen consists in degenerative changes, and comes late in life; but there are evils attributable to the inordinate exercise of small groups of muscles which present themselves even in youth. When inspecting a button-mill in Birmingham some years ago, I was informed that the girls employed there, whose whole work consisted in a few rapid manipulations required in the perforation and drilling of bone buttons, and which had to be repeated with great rapidity an innumerable number of times each day, occasionally passed into a morbid nervous state, in which they could not keep their hands still, even when labour was no longer required of them. Girls in this state, which generally occurred in those new to the business, might, I was told, be seen going along the streets after their work was over with their fingers moving involuntarily, as if they still guided the endless procession of buttons, or with their hands jerking aimlessly about. This state, analogous to chorea, or St. Vitus' dance, was evidently due to an erethism or morbid excitement of the centres in the brain for the hand and fingers. No doubt in a majority of cases it ultimately subsided without any disastrous consequences; but sometimes probably it was propagated to other centres, causing hysteria or insanity; and sometimes it sowed the seeds of brain disease, destined to grow up in after years. Such a state cannot be regarded as free from risk, or as likely to conduce to a healthy and well-balanced evolution of the mental powers.

Affections similar to those of the hammermen and button-makers occur in various occupations in which delicate, associated, and acquired actions are involved, and these affections now form a group which is called professional kineses. The best known of these affections is writer's cramp or scrivener's palsy, in which spasm and powerlessness of the fingers and wrist result from excessive pen-driving, carried on long after a sense of fatigue had given warning that it should be discontinued. The over-taxed right hand loses its cunning, the fingers turn stiff and unsteady, or start about, and are ultimately useless, owing to exhaustion and perhaps congestion, and degenerative changes in the brain-cells on which they are dependent for guidance. Pianoforte players occasionally suffer from a similar disease, when they have intemperately pursued their art.

In the affections just alluded to, the excessive exercise has operated in each case on only a limited group of motor centres, and consequently only local disturbances of function have resulted; but where the excessive employment of the muscles is general, so that a large area of motor centres are kept in violent action, then more general disorders accrue. Thus in the dancing maniacs of the Middle Ages, and in religious revivals in England and America in modern times, in which, with intense fervour and enthusiasm, there has been associated violent and prolonged muscular exertion, general convulsions have been constantly observed. After jumping, whirling, gesticulating, and howling, with extraordinary fury for long periods, the participators in these assemblies have often dropped down in epileptic fits. In Ferrier's experiments it was noticed that, whereas the application of the electrodes to one centre or group of centres caused local movements, their application at points widely apart, so that a whole hemisphere was included in the electric stimulation, produced general convulsions. And so it would seem that immoderate and vehement functional activity of one centre or group of centres is prone to induce chorea, and of a huge number of centres convulsions. Epilepsy is sometimes brought on in children predisposed to it by violent over-exertion, and Dr. Ireland has made the curious observation that epileptic idiots are very apt to have fits brought on by simply looking at children dancing. In nervous children, a state of extreme muscular restlessness, accompanied by startings and tremors, follows not seldom any unaccustomed and impetuous bout of muscular activity; and young ladies are occasionally in a similar condition after a ball, where they have had plenty of partners, and fall into the pernicious habit of taking chloral and other drugs, in order to calm their excited nerve-centres.

Excessive muscular exercise, when taken regularly, systematically, and persistently, has effects entirely different from those just enumerated as due to violent exertion. It tends to starve the brain, or some portions of it, by detaining large quantities of blood in the muscles to the detriment of the brain, and by limiting cerebral activity to certain tracts, and leaving other tracts wholly uncultivated. Professional athletes, and men entirely given up to sports of any kind implying great muscular effort, are generally dull and stupid; and a distressing hebetude creeps over boys who are permitted altogether to neglect school work and concentrate their energies in gymnastics. It seems certain, too, that with the stunted growth of body that results from severe physical toil at the formative period of life there goes some limitation of mental capacity or perversion of moral nature. The little, unshapely men and women that have grown out of factory children are surely not all that they would have been in faculty, temper, and habits had they been exempt from grinding labour in their early years. And local defects or deformities arising out of premature, inordinate, or irregular muscular action in weakly persons are also harmful to the nervous system and its functions. The twisting of the vertebral column, called scoliosis, which has its origin in the position in which delicate children are made to sit when writing, cannot facilitate the functions of the spinal cord, and bow-legs, a withered arm, or a round back, must be a perpetual provocation of chagrin, and must sour many a naturally sweet disposition.

"No knight of Arthur's noblest dealt in scorn;
But if a man were halt, or hunched, in him,
By those whom God had made full-limbed and tall
Scorn was allowed as part of his defect."

In dealing with local muscular defects and weaknesses, much advantage may be obtained from the employment of the medico-gymnastic machines which have recently been introduced into this country from Sweden. The elaborately constructed apparatus now in use permits the exercise of separate sets of muscles with a minimum of exertion to the body, and the degree of force used can be regulated with exactitude. Invalid children, with tendencies to nervous disease, may often be much benefited by a judiciously-arranged course of active and passive exercises as devised by Zander.

Food.—Food bulks much more largely in the mental life of young children than in that of grown people, and, without being greedy or gluttonous, they look forward to it with eager anticipation. Had we a veritable transcript of their thoughts during their moody moments, we should probably be shocked by the frequent references to comfits and comestibles, until we reflected that an exact reproduction of our own hidden cogitations might perhaps also reveal our favourite foibles to an extent that might be considered scarcely creditable to us by our friends. In the castle-building of children, and in their dreams, in the rewards they bestow on virtue and the punishments they allot to vice, things that are good to eat and that are nasty play a conspicuous part, and I have often thought that in writing stories for children—stories really for children, and not merely nominally addressed to them while actually intended to tickle the fancies of grown people—this great truth should be borne in mind. The ancient rhymers of the nursery did not forget it, but have studded their ever popular and delightful verses with profuse allusions to the pleasures of the palate. Children of all tastes may find in their stimulating ballads faint revivals of those flavours to which they are peculiarly partial, whether these be connected with plums and tarts, curds and whey, or strawberries and cream. And this dominance of food over the imagination is not confined to very young children, but is to be found in boys and girls, and even sometimes in young gentlemen and ladies. It remains, indeed, until other interests and the awakening consciousness of new wants dispute its supremacy. After infancy, of course, its existence is concealed and repudiated, for it is a canon of the ascetic philosophy, which still keeps its grip on us, that natural appetites are disgraceful, and this is, of course, indoctrinated in the young. But no one can have been much with schoolboys without observing how freely and frequently their thoughts turn to "grub," or have obtained the confidence of school-girls without discovering a strong leaning to chocolates and confectionery.

Alimentativeness, as the appetite for food and drink has been called, is indeed a primitive propensity of mind, to be distinguished from hunger and thirst. These no doubt form its foundation, but they depend probably upon sensations derived from the stomach and its associated viscera, whereas alimentativeness is also in relation with sensations of taste and smell; and it is certainly a remarkable coincidence that Ferrier, in localising taste and smell in the lower part of one of the lobes of the brain, has come close to the site of the old phrenological organ of gustativeness or alimentativeness. It is by inherited activities in the nervous substrata of this mental process that animals are able to select that kind of food which is suitable to them, and to reject that which would be prejudicial; and although this instinctive prescience has been to some extent lost in man, there has been obtained in place of it an infinitely enlarged range of healthful indulgence. Cookery has been jocularly spoken of as one of the tests of civilisation, and a great principle is couched in the joke, for the progress from barbarism to culture has been invariably marked by a multiplication of food stuffs, and augmented care and skill in dealing with them. The spices of the East have been the goal of Western enterprise, and the appetite for food and drink has grown more elaborate and refined in each succeeding century. And that appetite has not now completed its intricate transmutations and reached a stationary condition. It is still being modified, and the nature of the modification impressed on it will depend, in some degree, on the feeding of children. Tastes are chiefly inherited. This is seen in national and in family partialities for particular articles of food. But the transmission of distinct alimentative tendencies is, perhaps, best recognised in the reappearance of antipathies in several generations. A grandmother, mother, and son have been known all to suffer from an unconquerable dislike to eggs; and through three generations a repugnance to those usually-acceptable vegetables, green peas, has also been traced. A mother, who until the age of fifteen had been nauseated by the smell of cheese, then suddenly felt a craving for it, and continued to eat it with relish for the rest of her days, and one of her daughters went through precisely the same experience.

The food appetite is liable to vicious exaggeration, to abolition, and to morbid perversion. When humoured and pampered, after youth is over, it may attain a repulsive ascendency; and when altogether neglected it may dwindle into insignificance. As the result of disorder of the brain it may disappear, so that in cases of insanity food may be abstained from with no suicidal intention, but simply because the desire for it never arises. A similar state of things has been artificially produced in animals by the destruction of certain parts of the brain. In other cases of insanity, an extraordinary and insatiable voracity is developed; and in the condition called bulimia, this is the most prominent symptom of the mental disease. A congenital case of bulimia in a woman was observed in Paris. In her infancy she ate four times more than other children of the same age. At school she devoured the rations of all the scholars, and in the Salpêtrière Hospital it was found impossible to satisfy her with less than eight or ten pounds of bread daily. Nevertheless, she there experienced two or three times a month great attacks of hunger (*grandes faims*), during which she devoured twenty pounds of bread. If during these fits any obstacle was opposed to the gratification of her imperious desire, she became so furious that she used to bite her clothes and even hands, and did not recover her reason till hunger was completely satisfied. Being one day in the kitchen of a rich family when a dinner-party was expected, she devoured in a very few minutes the soup intended for twenty guests, along with twelve pounds of bread. But besides inordinate voracity for food, misdirections of the natural appetite are not seldom met with amongst the insane, who will eat husks and garbage, and even such indigestible articles as newspapers. In lunatics of this type, we see illustrated that earth-hunger of which we have heard much of late, for they greedily devour dust and pebbles. Lunatics sometimes die mysteriously, and then their stomachs are found to be loaded with stones, which they had surreptitiously swallowed; and at one of our idiot schools may be seen a perfect model of a girl's stomach in a compost of threads, leaves, and fibres, which she must have been consuming for years unknown to her attendants. In infants and young children, depraved or perverted tastes, such as a preference for salt over sugar, or a liking for soap, ought to create apprehensions of mental defect, such eccentricities of appetite being often exhibited by those who prove imbecile when a little older; but in girls and young women such phenomena are only indicative of hysteria. During hysterical states chalk and cinders are much sought after, and at the same time the odours of assafetida and valerian are pronounced delicious.

The first and most important question touching the food of children, in relation to education and nervous development, asks what is to guide us in determining the amount supplied to them. Are we to follow Mr. Herbert Spencer, and say that appetite is the best guide, or to adopt the creed of those stern parents who insist that all children are prone to over-eat themselves, and must be taught abstemiousness? It may be admitted that appetite is the best guide to the lower animals in feeding, to infants, and to full-grown men and women when in health, and yet it may be consistently denied that it is the best or sole guide to children. Even in animals, appetite can only be implicitly trusted when they are in a state of nature, for whenever they are placed in artificial circumstances, caged, or domesticated, it ceases to be trustworthy, and unless subjected to reasonable control leads them into excesses which shorten their days, as the untimely fate of innumerable pet dogs bears witness. Well, an infant may be said to be analogous to an animal in a state of nature, and a child to an animal caged or domesticated. Day by day the life of the child becomes more and more artificial, and for a long time it has to grope its way along in a dim twilight region—between the light of nature and the light of reason. And here it is that it needs the guiding hand. It has its appetite for food, but that is not in a state of nature, for a long line of domesticated ancestors have been assiduously improving on it, and the child receives it with its original bent, to be sure, but with numerous subsidiary inclinations, which deflect it more and more from its original course as life goes one. Then this improved appetite has to operate under improved circumstances, being solicited by temptations of a kind and intensity that could not exist in a state of nature. Doubtless, in the course of time, even the improved appetite in artificial circumstances would find out what was best, and become again a safe guide; but in this, as in many other matters, may it not be prudent to anticipate the teachings of experience, and prevent many painful lessons which may leave injurious traces behind them? Even amongst the lower animals, vestiges of parental control over appetite in offspring are not wanting: for a cat that will never interfere with her kittens in taking nourishment when they are young, may be seen driving them away from the breast when they become older, and plainly intimating, by huffing, that she thinks they have had enough.

To country children, leading simple lives and with only simple viands placed before them, appetite is a sufficient guide; but to town children, leading highly artificial lives, and with all sorts of dainties at their command, it is not always a judicious mentor. Excesses in porridge and milk are scarcely to be feared, but a surfeit of plum-cake is not an impossible occurrence. The safe rule would seem to be that the staple articles of diet—to wit, porridge and milk or bread and milk—should be allowed at discretion, but that all other viands should be meted out with a due regard to the height, weight, and work of the child, and the character of its dietary as a whole. Thus will the two evils, over-feeding and under-feeding, be equally avoided—over-feeding, with the dulness and hebetude, or dyspepsia and irritability, which attend it; under-feeding, with the listlessness, weakness, and degenerations which follow in its train. Of the two, the latter is unquestionably the more to be dreaded, and it is the one of which the pernicious effects are infinitely more common. The system can in great measure, in youth at least, protect itself against serious injury from repletion, but it has no means of averting the baneful consequences of starvation. Occasionally, in the homes of the rich, children suffering from a superabundance of food are to be met with; but everywhere, and at all times, children may be seen scarred and blemished by want. Could a generous and wholesome dietary be provided for all the children of the poor, one-half of the disease, pauperism, and crime that now burden and distress the country would have disappeared in the next generation; for deficiency of nourishment has a degenerating and vitiating influence upon all, but especially upon the young. It stunts their growth, "cheats them of fair proportion," renders them peculiarly subject to epidemics and infectious diseases, and sows in them the seeds of a whole garden of diseases. It has been said that the brain and nervous system are the last parts of the economy to suffer from starvation; but this opinion, founded on the observation that after death from inanition the brain has been found plump and full of blood, when all the other organs were shrunken and bloodless, is not any longer tenable. During quick starvation there come, with the pain in the stomach, giddiness with the sense of sinking, mental depression, and, later on, a tottering gait, staring eyes, outbursts of weeping, imbecility or maniacal attacks. During more gradual starvation, symptoms of brain disturbance are never absent. Famine has invariably brought with it mental disquietude or weakness. "The love of purposeless destruction exhibited by the Parisian Communists," says Dr. King Chambers, "may be fairly credited to deficient food. No well-fed people could have wrecked the Vendôme Column or burnt the Town Hall and Tuileries, of which they were so proud. They were like hungry children smashing their dolls. And Thucydides, Boccaccio, and Defoe are all agreed as to the hideous wickedness exhibited at Athens, Florence, and London during their famine fevers." But even when the deficiency of food stops far short of starvation, very deleterious consequences may be seen in the nervous system. Whoever has had opportunities of ascertaining the condition of prisoners on their discharge from prisons on the completion of short sentences, will probably have noticed in them a dulness and torpor of intellect or depression of spirits which it is not difficult to connect with the bare subsistence dietary of their imprisonment, for it seems quite possible so to dole out nourishment that weight is maintained for a time while yet the brain is suffering grievously—an observation which suggests that the brain, instead of being the last, is the first part of the system to feel injuriously any reduction of nourishment. The fact is, that those who have alleged that there has been no impairment of health on bare subsistence dietaries have not taken means to gauge the mental functions in those who have had to live on them. No regular brain-worker, who knows that the deprivation of a single dinner would throw him out of gear, will believe that the brain is the last part to suffer from inanition.

Now, it is an old established law that the younger a human being is the more easily is it starved, and to that old law may be added a more modern one—that the most actively growing parts are the earliest and most injuriously affected in starvation. From which it may be deduced that any insufficiency of food will tell more disastrously on children than on adults, and will be especially liable to cripple them at their times of rapid development. It is, therefore, peculiarly incumbent on parents and guardians, and all who have the care of children, to see that they are liberally fed. Much more attention than has hitherto been bestowed on them should be given to the dietary of schools, for, unhappily, Dotheboys Hall is not, as had been fondly hoped, a thing of the past. It is certain that cheap schools still exist in this country in which gross abuses abound.

And there is another matter in connection with the evils arising from inanition at developmental periods to which the earnest attention of parents and guardians should be given. Young girls, falling under strong religious impressions, often practice starvation as an exercise conducive to a spiritual life, and thereby endanger health. If debility and despondency are part of the spiritual life, they are right in the course they adopt; but if that life consists really in the subordination of the animal to the human element in our nature, they are egregiously mistaken. To starve was never yet to humanise. The chastening and restorative influence of occasional abstinence from selfish pleasures, and the luxuries that do most easily beset us, need not be disputed; but that is a very different affair from denying oneself necessary food. Attacks of melancholia and mania have been gathered as the fruits of Lenten observances, and the triumph of disease has not rarely been the end of long and painful struggles for self-subjugation. These are obstinate and difficult cases to deal with, for the commands of parents and the maxims of common sense weigh as nothing in a mind, already half-morbid, or swayed by enthusiasm, against the sanctions which seem to justify the course pursued. A combination of parental, priestly, and medical influence is sometimes needed to put an end or reasonable limit to fasting, even when it is manifestly doing harm; and no time ought to be lost in bringing this to bear on any girl under the age of eighteen who is known to practise fasting—genuine fasting being a rite unsuitable to most young women of the nineteenth century.

There is another kind of fasting sometimes encountered amongst girls of a different stamp and requiring different treatment—that is hysterical fasting, one of the expressions of the itch for sympathy and notice that is characteristic of hysteria. Here we have a mixture of imposition and pinching. Some of these fasting young ladies live well behind the scenes, and others have a hard fight with the pangs of hunger. The fate of the Welsh fasting girl was a lamentable exemplification of the hollowness of all pretensions such as hers. Cases of the same kind crop up from time to time. Joanna Nauton is said to have lived on lemon juice for seventy-four days, and instances are now and then brought forward as wonders of girls who have subsisted for long periods on Apollinaris water or the fragrance of lilies. The attitude to be assumed towards such cases is one of firm incredulity and calm insistence. The moral influence of a wise physician will do much, but the stomach-pump is sometimes necessary.

Sugar is a most valuable brain food, and should be served out in the nursery and refectory much more unstintingly than it is. The idea that it disorders the stomach, which has come down from a time when it was dearer than it is now, and when a senseless asperity tinctured both the diet and discipline of children, is not well founded. Sweets between meals are not to be countenanced, except as an occasional irregularity; but plenty of sugar and sweet things should be forthcoming at meals. And so, too, should fruits. The passion of the young for fruits might, perhaps, be described as a relict of our Simian ancestry, but it is also an expression of constitutional wants; and the intense ecstasy which children enjoy when partaking of it is something which should not be denied to them without good reason. "*Fruges consumere nati.*" To see (a truly pathetic sight!) a group of dirty, ragged children gathered round a fruit-shop window, gazing intently and silently at its forbidden treasures, while involuntary movements go on in the muscles of their little mouths, is to realise how deep and how active at one period of life, at any rate, the frugivorous appetite is. The avidity with which children eat crabs and sloes, or anything having the appearance of fruit, teaches the same lesson. The late Professor Laycock once came upon a lunatic, in the days when lunatics were less humanely treated than they are now, pacing round an enclosed and paved airing-court in a paroxysm of furious mania; but in his course, the Professor noticed he paused now and then to pick up any stray blade of grass that struggled up in the joints of the paving-stones, and this action gave a hint as to treatment. He ordered the maniac to be bounteously supplied with fruit and vegetables, and the result was gratifying, for after he had freely partaken of them his mania gradually subsided. This man was reduced by his mania to a mere automatic condition, in which his instincts had freer play than they have when the mind is sound, and then his blood state expressed through the nervous system, automatically, the need that existed in his system for vegetable acids, and these being supplied all went well. And so in children, the fruit-hunger may be taken as an expression of wants of the system, not to be neglected with impunity.

What has been said as to the importance of the share taken by impressions and ideas about food in the psychical life of the child, and in giving a complexion to his emotions, suggests that its diet should be varied in character. Much may be done to brighten the lot of children by catering for them with discernment, much to cloud their happiness by confining them to a monotonous repetition of the same sustenance day after day and week after week. They should not be made nice and epicurean, nor should their fanciful whims be regarded; but they should be encouraged to take what is placed before them with hearty enjoyment, and care should be taken that what is placed before them is toothsome and varied in character. Variety in food helps to good digestion, good nourishment, and good spirits, as farmers and physiologists can alike testify. The late Mrs. Nassau Senior, in her "Report on the Education of Girls in Pauper Schools," ably advocated the introduction of more variety into their rations. "It is said," she remarks, "by those who think they see insurmountable difficulties in the way of bringing in a variation of diet, that the children of the London poor get none, but only ring the changes on bread and butter, red herrings, cockles, hot potatoes, and sugar plums. But I know that tripe, and cow heel, and sausages, and occasional rashers of bacon come in to vary the cockles and red herrings; nor must it be forgotten that costermongers are found selling the contents of their barrows in the poorest parts of London. The street children thus get apples and pears, radishes and lettuce, currants and blackberries; even penny slices of pine apple are occasionally within their reach. The children in these schools get a great deal more meat than in their own poor homes, but they have little or no green vegetables, no fruit, and, as a rule, very little sugar, all which things should be in the dietary of children. . . . . To have exactly the same sort of food week by week, over and over again, all through the year, and year after year, cannot be good for children. . . . . Though children in their poor homes may not get food equal in nutritious value to the school diet, yet they get unexpected things on hot-dinner days; they get it really hot and they eat with relish and enjoyment, and do not leave half their dinner, as is the habit of many pauper children on soup day. Food eaten with pleasure nourishes far better than a superior diet eaten for any reason without enjoyment."

INTELLECTUAL EDUCATION.

There is, perhaps, some danger that the popular awakening which has taken place in recent times to the importance of educational questions may lead to the injudicious application of educational processes. In the keen struggle for existence that goes on in these days it has become apparent that individuals and states will prove prosperous in proportion as they are instructed, and so we have passed from *laissez faire* to compulsion, and the boon of education has been conferred on our lower and ignorant masses. But the education of the masses, in the thorough and liberal spirit in which it is now conducted, entails upon the middle classes the necessity of a higher and better training than they have been heretofore accustomed to, if they would maintain their position; and the advance of the middle classes in sound learning imposes on the upper classes the duty of the highest possible cultivation, if they would still lead and rule. There is a general upheaval, therefore, in educational matters—a straining forward, which may end in misfortune if reasonable restraints be not imposed, for it is very certain that immense numbers of the children now taught in schools, and pushed on with a zeal that is assiduously stimulated in every possible way, are ill-prepared for mental exertion or brain-work. Some are constitutionally delicate, some are imperfectly developed, some are badly nourished, and many lack that inherited aptitude for study which deprives it in great measure of its irksomeness and galling qualities. But to push such children forward and overburden them with tasks is to sow widespread the seeds of nervous degeneration; and a regard for the future of the race must therefore constrain all medical men to preach constantly and emphatically, in the midst of the indiscriminate educational fervour that prevails, the wisdom of caution and the danger of brain-forcing. It cannot be too often or too earnestly impressed on parents and teachers that to overwork the immature brain is to enfeeble it, and that the early talent which they seek to evoke is not a thing to be desired. A good start in a race is considered so advantageous that all those interested in a child experience pride and pleasure when it shoots ahead of its compeers in age, and displays an ability and capacity for learning very unusual at its years, or some special gift which commonly belongs to adult life. But the feelings which ought to arise in those interested in such a child are disappointment and solicitude, for precocity is really the sign either of an inferior mental organisation or of morbid excitement. The biological law is, that the higher the organism the longer it takes to evolve, and early mental evolution means, therefore, intellectual inferiority. A glance at the animal kingdom must satisfy any one of this. The chicken walks and talks in its own fashion, and feeds itself as soon as it is out of the egg-shell; the rabbit, when a fortnight old, is capable of every movement and manifestation of intelligence that it is in its nature to attain to; and the puppy has got rid of its clumsiness, and is an elegant and finished dog in the course of a few months. But the human infant is only beginning to walk when twelve months old, and is not fully master of its own situation for at least twenty years after that. And this tardy development of our own race, when compared with the races of animals, is not an instance merely of proportion or balance of parts corresponding with the greater age we live to, for in some animals with a longevity at least equal to our own—for example, the elephant—mental maturity is reached in a comparatively brief period. The slowness of evolution in man is really due to the slow growth of his brain, which goes on budding, expanding, and weaving its interlacements until nearly middle life, when alone can his education be said to be completed. The simple smooth-brained animals, like the chicken and rabbit, have almost finished their cerebral evolution at birth; the poorly convoluted-brained animals, like the cat, complete the process rapidly, but the richly convoluted-brained animals, like the human subject, have a long-deferred maturity. The duration of dependence on parental protection and support is a rough measure of the height to which the animal will attain in the scale of being. And within the human family itself the same thing holds good, for travellers in all regions comment on the great precocity of children among savage and semi-civilised peoples, and on the early arrest of their mental growth. Consul Churchill, in his report on the trade of Ghilan, states that the children in that part of Persia are vastly superior in intelligence to European children of the same age. The development of their intellectual faculties in early years is so astounding that small children will hold their own with grown-up persons, and talk freely on subjects that would make our little folks at home stare with wonder. But these Persian children make no further advance in intelligence after six or seven years of age, and the Persians, as a nation, move not at all, but are just what they were 500 years ago.

At home the premature sharpness and cunning of our street Arabs are proverbial, and contrast strangely with the obtuseness and simplicity of well-to-do and country children; but the street Arabs finally fall far short of the latter in intelligence. Girls are in all countries more precocious than boys, but they stop at a lower point in mental evolution, and it might be argued with some force that nineteenth-century children in Europe ripen in intellect somewhat later than their forerunners did two or three centuries ago. And the history of singularly precocious children bears out the same truth. The young Rosciuses and infant prodigies who are brought in with the walnuts and the wine, to astonish the guests by their wisdom and attainments, generally end in the feeblest of commonplace—unless, indeed, they die young, being instances of that other species of precocity which is really a symptom of disease, and which was well known in Shakespeare's time: "So wise, so young, they say, do ne'er live long." Of this species of precocity many painful illustrations might be referred to—cases of gifted children who have fallen victims to tubercular disease just when they were giving promise of marvellous achievements. Typical cases were those of Lucretia and Margaret Davidson, recounted by Washington Irving, who died of consumption in early girlhood, leaving copious poetical remains of exquisite sweetness and much literary merit. A typical case also was that of Pet Marjory, whose memory is preserved as precious for ever, like a fly in amber, because she lay in the fold of Sir Walter Scott's plaid and sat on his knee, repeating to him Constance's speeches in "King John," till he swayed to and fro, sobbing his fill, and who died when seven years old, after inditing letters that would have done credit to a woman of forty, and verses of which the following may be received as a specimen, reproduced in her own orthography:—

> "I love in Isa's bed to lie;
> Oh, such a joy and luxury!
> At bottom of the bed I sleep,
> And with great care within I creep;
> Oft I embrace her feet of lillys,
> But she has gotton all the pillys.
> Her neck I never can embrace,
> But I do hug her feet in place."

And with children of this class, as well as with the diminutive saints whom we find enshrined in religious literature, it is always the same story; in the midst of their matin bloom they droop and fade, utter that portentous cry, "My head! My head!" and sink under acute hydrocephalus; or they are snuffed out by some childish ailment from which their less gifted brothers and sisters escape; or they linger on into adolescence, in ever-increasing debility, and then perish of pulmonary consumption. Pernicious precocity, as this may be called, to distinguish it from that forwardness of intellect which is only a sign of an inferior organisation, is sometimes associated with visible deformity, which arrests attention, and stamps its true character. The head is enlarged, and the square forehead presents those prominences which are even popularly recognised as indicative of water on the brain, or the abdomen is tumid owing to degeneration of the intestinal glands, or the spine bends because of disease of the vertebræ or failure of enfeebled muscles to keep it erect, or the joints are swollen, and the bones crooked by rickets. But in a majority of cases of pernicious precocity no such ostensible signs of disease are present. The child is comely and well-formed, with no cachectic brand upon it, and then it is that the nature of the early efflorescence is mistaken, and that morbid tendencies are fostered and encouraged. For pernicious precocity is promoted and driven on towards its lamentable issues by whatever stimulates the brain to increased activity, by praise and public display, by rivalry and competition, and, above all, by excessive indulgence in mental exercises and bookwork. And not only so, but it may be induced in those who are not constitutionally afflicted with it by the timely and merciless exercise of the schoolmaster's arts. If a number of infants, healthy, but of the more delicate sort, well-bred, and of nervous temperament, were taken from the cradle, and subjected to a mental discipline as severe as that through which John Stuart Mill passed, and from which he emerged with his perfectly trained but passionless intellect, there can be no doubt that a large proportion of them would develop extraordinary precocity, and die of brain disease, while others would come to exhibit preternatural stupidity. And if even healthy children may thus be drilled into brain disease, how much more likely are those who are already tainted with some disorder, or whose vital powers are naturally feeble, to suffer from premature stimulation of the cerebrum! There are great risks, and no genuine gain in precocity. A few instances can doubtless be quoted of precocious children who have attained to eminence in after-life, but even in most of these instances the drawbacks that attend a premature activity of intellect are sufficiently evident. Chatterton was a boy-poet, but he committed suicide at eighteen. Raphael was a painter by the time he could walk, but he died at thirty-seven. Edgar Allan Poe was a show child, and when six years old declaimed the finest passages of English poetry with great effect; but his career was besmirched with vice and folly, and he, too, died young.

On the other hand, equally striking instances might be adduced of the lateness with which genius sometimes attains fruition. Handel was forty-eight before he "gave the world assurance of a man." Dryden came up to London from the provinces at thirty, not knowing that he could write a line of poetry; and Milton was over fifty, blind, and fallen on evil days, before he began his great work, although his "Comus" had been written at twenty-six. But it is not from exceptional cases of quickness or tardiness of mental growth that practical rules for guidance in education can be drawn, but from a wide survey of child nature, and a study of the principles of physiology and evolution; and these combine to teach that precocity is to be deplored and avoided, and that the practice of commencing artificial education too soon, which is the fertile source of precocity, and to which the circumstances of the age are an ever-strengthening incentive, must be jealously restricted.

A misapprehension as to what really constitutes education, and of the relative value of its component parts, is probably responsible for many of the evils that have resulted from premature pressure upon the brain. The idea is that nothing but the methods of the schoolmaster is worthy of the name of education, and that a child is wasting its time when it is not seated on a bench with a book in its hands. But the fact is that the least valuable part of education is that which we owe to the schoolmaster, and that the most precious lessons are those which we learn out of school. The schoolmaster, it might with some justice be said, only gives the finishing touches to a process which commenced at the moment of birth, if not much earlier. The first moment of life is, perhaps, the most instructive of any, and at any rate vast stores of knowledge indispensable and of paramount importance are picked up spontaneously in babyhood, and in the wanton playfulness of early years. It is then that innumerable serviceable reflex actions are organised, that sensation and perception are most active, and that acquaintance is made with the world and the properties of matter. For the first six years of life a child has quite enough to do in learning its place in the universe and the nature of its surroundings, and to compel it during any part of that period to give its attention to mere words and symbols is to stint it of the best part of its education for that which is only of secondary importance, and to weaken the foundations of its whole mental fabric. "The education of the senses neglected," says a great authority, "all after-education partakes of a drowsiness, a haziness, an insufficiency which it is impossible to cure." But the education of the senses will not be neglected if children are only placed in positions in which abundant and varied sense impressions are accessible. They are eager to see, hear, taste, touch, and handle; and left unrestrained will, step by step, familiarise themselves with the properties of matter, proceeding even from the simple to the more complex. The child embarks on its career just as ignorant that a stone is hard, or sugar sweet, or that snow will melt, as he is of the diameter of the sun and the definition of a parallelogram, and he must have time to acquire these common and fundamental truths just as much as he must have time in which to learn the alphabet and multiplication table. And when given time for such elementary but all-important studies, and gently directed in them by the intelligent interest and sympathy of his seniors, he will advance in self-evolution, acquire the habit of exhaustive and minute observation which is so essential to success in many occupations, and contract the spirit of philosophical inquiry—that spirit which led Schiller when a boy to climb a tree during a storm to see where the thunder and lightning came from, and which has prompted to all the investigations and discoveries that have ameliorated the condition of mankind. Vivid and complete impressions are all essential to subsequent mental growth, and these can only be properly acquired at the time when the sense centres are most active—that is to say, in the first seven years of life.

The best school for sense education is, of course, the home and the country. Roaming about unconfined in fields, orchards, and meadows, amidst the riches and beauties of nature, or busying itself with its toys, or the objects around it in its home, the child speedily and agreeably picks up knowledge. To comparatively few children, however, are such advantages accessible. Fields, orchards, and meadows are beyond the reach of those who are pent in large and crowded cities, and the mud of the gutter and the kitchen cinders are the only toys that fall to the lot of thousands that are poorly born.

Miss Rossiter has shown with rare philanthropy what benefits accrue to London children from brief glimpses even of sky and flowers, and the day may perhaps come when means will be taken to secure such advantages to the children of all our greater centres of population. But meanwhile, turning from what is desirable to what is practicable, we must strive after proper playgrounds for town children, the improvement of their homes, and the introduction into them of some objects of interest and beauty, and the extension of the Kinder-garten system, which is founded on a scientific basis, and affords in the object-lessons, which bulk so largely under it, the best substitute for close personal communion with nature, and an admirable introduction to accurate perception and comparison, for all children, whatever their opportunities of sense-education may be.

It is impossible, in a few words, to convey any adequate conception of the details of the Kinder-garten system as elaborated by Fröbel and his disciples, nor is it, perhaps, necessary to do so, as that system is now tolerably well known among us, through the writings of Miss Shirreff and others, and through the operation of the schools which have been established to carry it out. The system is founded on a study of mental development, enjoins the constant fusion of work with play, and keeps incessantly in view these great principles: that we must proceed from the empirical to the rational; that instruction, to be safe and useful, must create a pleasurable excitement; and that self-development must be encouraged to the utmost. The games, which play so large a part under the system, are, at one and the same time, toys, instruments of instruction, and links in a chain stretching from dense ignorance to a just comprehension of the physical universe. Dances, or rhythmical movements, timed by singing, are prescribed for the children who are not of an age to employ themselves in any work of skill, and the songs which accompany the dances tell some story of bird, beast, or plant with which the children have been made acquainted, or describe some kind of manual work which they have been taught to perform. Gifts are presented to them, which they employ as playthings and in exercises, and of which the various qualities are unfolded to them. Thus coloured balls are placed in their hands, and attention is drawn to their form, colour, density, and weight, new words being added to the infantile vocabulary while they are passed from hand to hand and child to child in regulated order, and quick and slow time; so that all the advantages of drill may be obtained. Cubes and cylinders are next added to their stores, and comparisons are instituted between them and the sphere, the characteristics of sides, surfaces, angles, and lines being pointed out while novel movements are devised; compound cubes, made up of eight smaller cubes, are next distributed, and with these they are taught to distinguish the whole from its parts, to add and subtract, and to construct figures in imitation of familiar objects, such as tables and flights of steps; little narratives or facts of natural history being mingled with and made to hinge upon their performances. Somewhat later, small sticks and thin flexible laths are given to them, by which their arithmetical instruction is continued, while interest is still further excited by the formation of figures, which please by their symmetry and stimulate to the exercise of ingenuity. Next in the course of instruction come metal rings and portions of rings, which enable the teacher to comment on the metal of which they are made, and on the properties of circles, and the children to enter on a new series of manipulations. As further stages in Kinder-garten instruction may be named plaiting with strips of paper and weaving with coloured threads, folding and cutting out figures of various shapes and dimensions, modelling in clay, to which Fröbel attached great importance, and drawing, first of geometrical figures and symmetrical patterns, and then of natural objects. Only when some progress has been made in drawing, is writing attempted, and writing and reading both come much later under the Kinder-garten system than in ordinary schools. It might be questioned whether reading and writing ought to have any place in the Kinder-garten system proper, which aims at teaching, not by books, but by the observation of nature, and the training of the capacity of dealing with outer things; but the transition from the Kinder-garten to the ordinary school as now conducted would be too sudden and great, and the children so translated would at first be at some disadvantage in competing with those brought up under the old methods if some power of reading and writing were not conferred in the Kinder-garten stage. Hence, the Kinder-garten system, although really opposed to reading as an exercise for the very young, aiming as it does at the development of faculty rather than the acquisition of book-lore, yet includes elementary instruction in that art and in writing.

It will be seen, even from the foregoing fragmentary sketch, how closely Fröbel has followed the course of mental evolution as far as that is known to us. The earliest mental manifestations in the infant are the movements of his limbs, his cries, and the notice he takes of surrounding objects; and so Fröbel begins the work of education by dances and songs and the presentation of attractive objects, taking captive, as it were, by kindness the wild propensities and training them to docility and regulated action. The next striking characteristic of the infant mind is that curiosity which leads to incessant questioning and fingering ; and this, too, Fröbel utilises, stimulating it by a succession of novelties and surprises, converting it into the habit of rational inquiry, and building upon it a knowledge and understanding of things. A subsequent trait in infancy is the desire to be useful and construct, and this, too, Fröbel takes advantage of ; for all his teaching ends in work, the pupil having to reproduce what he has learnt, and express his own thoughts and fancies through the medium of various exercises. And other characteristics of the infant mind are not overlooked. The desire for companionship is made the basis of a sound social training, and the sense of beauty is assiduously cultivated and refined from a rude taste for bright colours to a discriminating appreciation of the subtleties of art. The naturalness and comprehensiveness of Fröbel's system recommend it to the physiologist and practical physician, but to the latter its chief practical merits are that it postpones the commencement of ordinary school instruction, and insists on a sense of enjoyment as an accompaniment of work. So many delicate children are injured by being set too soon to pore over books, and so many prejudiced parents scout the idea of education being altogether put aside for a season, that it is a boon to have schools to recommend which will not prove hurtful, and which may even effect an improvement in health coincidently with a development of capacity. The Kinder-garten is suitable for all children from three to seven years of age, and fragile children with precocious tendencies may properly be kept at it for a year longer. As a guide to the ages at which average children ought to pass through schools of different grades, the following table, prepared by Professor Lawrie, of Edinburgh, an educationist who never overlooks physical conditions in relation to instruction, is here introduced :—

From 3rd till 6th year ...	Kinder-garten School.
„ 6th „ 8th „ ...	Infant School.
„ 8th „ 15th „ ...	Primary School (Lower Primary to 12th, Upper Primary to 15th).
„ 15th „ 18th „ ...	Secondary and High Schools.
Above 18th year	University.

The system of teaching which is characteristic of the Kinder-garten should not be confined to these institutions, but object-lessons should be given much more freely than heretofore in primary and secondary schools, and should merge ultimately into the special teaching required by the naturalist and man of science. Children are intensely interested in the world around them, and the pleasure which they manifest in watching insects and gathering flowers and shells and pebbles may be made subservient to their advancement in sound knowledge.

The man or woman who does not possess the vital and formative knowledge of the world and the laws which govern nature is a very helpless being, and the most intimate acquaintance with the workings of the human spirit's activity in ancient Greece and Rome will never compensate for the lack of this knowledge. And yet it is only given in these days, even in high-class schools, in very sparing amount, these establishments being still under the tyranny of the humanists. The knowledge of man himself is best approached through a knowledge of the world which he inhabits and the organic nature of which he forms a part, and must, in order to be useful, include a knowledge of his bodily framework as well as of his spiritual mechanism.

It has been said that one of the great merits of the Kinder-garten system is that it aims at giving pleasure throughout. It makes the happiness of the pupil the criterion of the success of the teaching, and its lessons are carried out amidst smiles and laughter. The hilarity of the Kinder-garten would be out of place in the primary school, where graver studies are pursued; but there is no good reason why the latter should be identified with contracted brows or tears. No doubt much progress has been made of late years in the way of rendering learning attractive, and of robbing it of its pains and terrors; but much still remains to be done to convert it into what it ought to be—an agreeable and bracing exercise. The healthy performance of function is either pleasurable or indifferent, and whenever it is accompanied by pain there is something wrong. And the knowing faculties are no exception to this rule. Their random activity is delightful to the child; their disciplined exercise should be, at least, free from suffering; at most, a sense of weariness should follow a long-sustained call upon them. In looking about us, in listening, in conversing, there is an expenditure of nerve force which involves waste and, ultimately, weariness. But strained nerve action involves something more than this, for it is accompanied by a sense of distress or painful effort. The weariness of unforced nerve activity comes gradually, and is at first, at least, so little painful that it is almost pleasant. But the weariness of forced nerve activity—that is to say, the sense of distress or effort that accompanies it—begins suddenly, and is always eminently distasteful. It is something superadded to common weariness, just as cramp is something superadded to muscular fatigue. The distress of forced nerve action or mental work is clearly a conservative indication. Touch may be long employed with nothing but weariness or exhaustion; it is only when contact is so rough as to cause excessive pressure or abrasion of the surface that pain is felt, and that depends on a new set of nerves, which pursue a separate path to the brain, being called into play. But pain does not quicken nor improve touch, but warns of danger; and neither does mental pain quicken nor improve mental action. The endeavour should be to educate with as little pain as possible, to lead on gently and gradually, step by step, ever enlisting interest, and sparing violent efforts and harassing application. To disregard the pain which accompanies forced mental labour, to push on in spite of it, may overcome and abolish it in time, but at a serious sacrifice. In the disorder called analgesia the sense of pain in a part is lost, while that of touch is retained in all its acuteness; and it seems that there may be a mental state analogous to analgesia, in which the distress of mental strain is no longer felt, while the power of acquisition and the ordinary sense of nerve weariness, leading to sleep at regular intervals, remains. Observations have been made on several cases in which enforced study that had been peculiarly painful and prostrating, but that had been sedulously enforced in spite of these drawbacks, suddenly became easy and exhilarating, and in which, not long after this strange emancipation from the immediate penalties of overwork, death took place from inflammation of the brain or pulmonary consumption.

Careful consideration must, therefore, always be given to the condition of any child who manifests extreme repugnance to school work, or who is obviously distressed by it, for there is still far too much forcing in schools of all classes, and but an imperfect recognition of the principle that action that causes pain is not healthful. True, in opening up new territory some strenuous toil is necessary, and there are certain higher mental powers, but little developed in the race and inherited in any considerable degree by but a favoured few, that can only be brought into cultivation by severe exertion; but these come late into operation, not until an age when the pupil can measure an ulterior benefit against a present discomfort, and pursue his work with a balance of pleasure. With all lower faculties, however, there should be the immediate gratification of activity; and when this is absent, or when its place has been taken by painful aversion, we may feel assured that there is something wrong, either bad teaching or brain forcing. Neuralgia has been called the cry of a nerve for more blood, and phrenalgia, or mind pain, is often the cry of the brain for more rest and exemption from efforts to which it is unequal. Indolence may sometimes be the passive resistance of the brain to destructive oppression, and a truant may possibly be a protestant against faulty scholastic methods.

The evils of brain forcing may arise at any stage, and in connection with any branch of education; but they are most likely to show themselves under a system of "cram" or spurt teaching, with a view to a specific examination, or of learning by rote and by rule, without any real understanding of what is being learnt. They are particularly apt to occur after the imposition of heavy tasks upon the memory, which in these modern times is not, perhaps, equal to the achievements that it performed in the past. The prodigies of memory which were not uncommon in Europe a few centuries ago are not now to be looked for. At the revival of literature, a man who had read a few manuscripts, and could repeat them, might travel from place to place and live by his learning; and the scholar had far more inducement to engrave the words of others on his memory, than to exercise his own judgment and invention. But in later times the case is greatly changed, and we must now go to India or China, where poems and scientific works are and have been for centuries transmitted orally from one generation to another, for such marvellous feats of memory. With us the ready access which all classes of the community now have to books and writing materials has undoubtedly a tendency to weaken the powers of memory, by superseding the necessity for its more extraordinary exertions. It was on this principle that the Druids (as we are informed by Cæsar in his Commentaries), although they knew the Greek letters, abstained from the use of writing for recording their theological and philosophical doctrines, lest by leaning upon a crutch they should weaken the limbs. We, with our pocket-books, calling-lists, encyclopædias, directories, and libraries, depend much less than our grandfathers did on the tablets of the brain. We do not inquire within for everything, but trust in large measure to external aids to memory. Conscious that lost knowledge can be easily recovered, we disburden ourselves of whatever we can commit to writing, or refer to in an index, and consequently we do not require of memory those arduous labours by which our ancestors used to brace its sinews. Some decay of mere verbal memory is, therefore, perhaps going on, though it is to be hoped that a better and classificatory memory is contemporaneously gaining strength and vigour. But the diminished power of verbal memory must make it more and more difficult for modern children to commit to its safe keeping heavy word tasks, and hence it is not surprising to find that, in them, it sometimes fails altogether when over-loaded, and goaded into fatiguing efforts. It is the memory itself that often gives way under such a discipline, becoming incapable of even ordinary exertions, or suddenly losing any extraordinary powers which it may have inherited or acquired. The late James Hinton, his biographer informs us, was remarkable for his memory as a boy. He could repeat as much as six pages of history verbatim for a morning's lesson; but one day, when rushing hurriedly from cricket to the schoolroom, there was a sudden lapse of this exceptional power, "a sense of goneness," as he said, and it never returned to him.

In Hinton's case there was nothing but the loss of the singular gift or trick of memory to deplore; but the disastrous consequences of overcrowding the young memory with facts and figures are not always thus limited to the seat of injury. Very often they involve that higher faculty which collects and combines materials for intellectual purposes, and so blunt the fine edge of talent, and render the mind generally sluggish and unproductive. Charles Dickens, with his quick insight and sympathy with the right, noticed the crippling effects of the cramming and forcing of memory, and happily hit them off in his description of Dr. Blimber's establishment.

"Whenever a young gentleman was taken in hand by Dr. Blimber, he might consider himself sure of a pretty tight squeeze. The Doctor only took the charge of ten young gentlemen; but he had always ready a supply of learning for a hundred on the lowest estimate; and it was at once the business and delight of his life to gorge the unhappy ten with it.

"In fact, Dr. Blimber's establishment was a great hot-house, in which there was a forcing apparatus constantly at work. All the boys blew before their time. Mental green peas were produced at Christmas, and intellectual asparagus all the year round. Every description of Greek and Latin vegetable was got off the driest twigs of boys under the frostiest circumstances. Nature was of no consequence at all. No matter what a young gentleman was intended to bear, Dr. Blimber made him bear to order somehow or other. This was very pleasant and ingenious, but the system of forcing was attended with its usual disadvantages: there was not a right taste about the premature productions, and they didn't keep well. Moreover, one young gentleman with a swollen nose and an excessively large head (the eldest of the ten), who had gone through everything, suddenly left off blowing one day, and remained in the establishment a mere stock. And people did say that the Doctor had rather overdone it with young Toots, who, when he began to have whiskers, left off having brains."

The dulness and simplicity induced by over-pressure upon young minds may amount to a pathological condition. Thus the late Sir Henry Holland said: "In the course of my practice I have seen some striking and melancholy instances of the exhaustion of the youthful mind by the over-exercise of its faculties. In two of these, unattended with paralytic affection or other obvious bodily disorder than a certain sluggishness in the natural functions, the torpor of mind approached almost to imbecility. Yet, here there had before been acute intellect with great sensibility; but these qualities, forced by emulation into excess of exercise, without due intervals of respite, and with habitual deficiency of sleep, had wholly disappeared." And besides general enfeeblement of mind, a loss of mental balance is seen as a consequence of injudicious forcing in education. Children previously bright and vigorous pass from time to time into what is called a brown study or absence of mind, or become eccentric in manner and conduct; this latter state being most often seen in those who have an inherited tendency to insanity, and in whom it often foreshadows, or leads up to, an outburst of madness.

But the evils of memory-stuffing and brain-forcing as carried on in schools, and sometimes under home-tuition, by tutors and governesses with more zeal than judgment, are not confined to mental failure and disorder and the frustration of all the hopes with which they were undertaken; they include a whole train of physical diseases, some of which fill with pain and bitterness what should be the bright days of childhood, radiant with joys such as the dim later years can never yield, and some of which place life in jeopardy. And it is not wonderful that they should do this, when the nature of their physiological effects on the brain and nervous apparatus is considered. The study of that one point in the human organism where during life we can, by aid of the ophthalmoscope, actually look upon a piece of nervous tissue—the fundus of the eye—where, through transparent media, we see the expansion of a nerve that is in close proximity to the brain, has proved that the nervous tissue in children is of a much redder tint than in adults. But this brighter redness of the nerve tissue in youth means greater vascularity and a more copious blood supply. Now, we have already seen that functional activity of nerve tissue is invariably accompanied by dilatation of vessels and an increased flow of blood to the part; and in the fundus of the eye we see this, as well as on the surface of the exposed brain. But in the fundus of the eye we can see more than this; for there we can watch the effects of overwork of the parts, which we have not yet been able to do in any exposed brain. In an affection of the eye, called hypermetropia, involving strain on the organ, the disc—that is to say, the nerve expansion at the back of the eye—becomes red and even swollen from overuse of the eye. The redness and swelling may become so marked that this at first comparatively unimportant condition, remediable by spectacles, is occasionally mistaken for neuritis, or inflammation, depending on cerebral disease. And this congestion and œdema from overwork of the hypermetropic eye throws light on the state of the brain that may be set up by functional abuse in educational forcing and cramming. Just as overwork of the eye causes congestion and œdema, or dropsy of the disc, so overwork of the brain causes congestion and even œdema of the overworked regions or centres in that organ. The overwork produces arterial fatigue and loss of arterial tone in those vessels that are kept unduly and too long dilated in order to supply the overworked tissues. Of course, overwork at any period of life may induce this series of events; but it is much more likely to do so in the young, in whom the nervous tissues are naturally more vascular, in whom there is greater vascular mobility, and in whom the blood supply is subservient to processes of growth, as well as to ordinary nutrition, repair of parts, and functional activity. Growth makes large demands upon the vessels, and so do all new developments of functional activity, so that the parts in which these are going on must always be in a high state of turgescence. "The neuroglia"—that is, the homogeneous substance in which the nerves and nerve cells are embedded—"the neuroglia," writes Dr. Bastian, "is the probable matrix wherein and from which new fibres and nerve cells are evolved in animals, of whatever kind and degree of organisation, during their advance in reflex, in instinctive or in intellectual acquirements. Some such process must take place, *pari passu*, with the acquisition of new knowledge and powers of all kind, and howsoever acquired. The acquisition of new powers or accomplishments must correspond either with more or less alteration of the old, or with the development of new structures in one or more of the various nerve centres." New processes of this kind, involving the elaboration of new cells and fibres from the neuroglia, which must be going on energetically in all education worthy of the name, contemporaneously with old and new combinations of functional activity in fully-formed parts, also call for rich inundations of the nutritive fluid, and keep the arteries and capillaries stretched to the utmost. If these processes be interrupted with sufficient frequency, if the strain of work be constantly shifted from point to point in the cerebrum, and if the general health be maintained at the highest pitch, then no evil results need ensue; but if these processes be too persistently kept up, if the strain be made too continuously on one region, or if the general health be allowed to flag, the stretched vessels lose their tonus, do not contract when the outside demand for their dilatation is no longer made, and so there is congestion of an area more or less extensive; while the watery fluid of the blood percolates through the distended vessels, and soddens and debilitates the nerve substance. It has been said that if there was a window in every human breast, society would go to pieces; and it might be added, that if there was a window in every human skull, some pernicious practices, very disastrous to society, would be abandoned. Could schoolmasters peer into the cranial cavities of their pupils, and see the palpitating brain within flushing fiercely in some regions, and pale and bloodless in others, under the pressure of mental work, they would better know where to pause in their impositions, and would avoid many failures and misadventures that may now be laid at their door.

But hyperæmia, or congestion with œdema, of portions of the brain substance is not the sole morbid change that is brought on by inordinate mental work. Independently of congestion and œdema, there may be failure or debility in certain kinds of brain function, connected, it may be surmised, with defects of nutrition in nerve substance. When the brain of a living mammal is closely scrutinised, curious variations in vascular turgescence may be observed in it. At one part there may be pallor, at another a distinct blush, during which minute vessels, before invisible, come into view. Indeed, a sort of rhythm may frequently be recognised in the alternation of dilatation and constriction of the arteries on the surface of the cerebrum; and this rhythm cannot be supposed to be in any way related to ideation, for the same thing is seen in the ear of the rabbit. It is inferred, therefore, that this rhythm is related to nutrition, and if it be so, it is clear that any protracted interference with it, as when enforced dilatation is kept up for prolonged periods by excessive application to study, may eventuate in imperfect nutrition of areas of brain substance. Again, spasm of vessels as well as dilatation may be responsible for some of the calamitous results of brain forcing, and this condition it is perhaps that accounts for some of its suddenly-established effects to which we have adverted. An irritative state of the brain ends in spasm of a group of vessels; this yields after a time, but the temporary vascular obstruction has caused an irrecoverable injury in the nerve elements with some secondary atrophy or wasting. The same sort of thing is seen in the eye. A small clot ultimately plugs one branch of the artery of the retina, but on its way temporarily plugs the whole. In some cases the initial loss of sight clears up, leaving only the segment of the retina, supplied by the still occluded branch-artery, blind; but in other cases it does not clear, even although all the arteries, save one, are seen to be pervious again, but there is permanent loss of sight and rapid general atrophy of the optic disc. When it is further remembered that blindness due to amaurosis and atrophy may date from a sudden loss of blood, it is evident that even temporary interferences with the blood supplies to active nerve tissues is full of danger.

The physical disorders which arise out of the vascular changes connected with excessive brain work which have been mentioned are numerous and varied, for the brain being in intimate communication with the whole being, there is not an organ or tissue that its abusive activity may not affect. The most formidable of them is acute hydrocephalus, or tubercular inflammation of the membranes of the brain—a fatal malady which, although especially connected with the scrofulous habit, is also sometimes indisputably connected with excessive use of the brain. There is no great distance between the congestion and dropsy which have been described and actual inflammation, and when vascular fatigue and loss of tone are brought on by vexatious study in the brains of sickly and scrofulous children, the danger of acute hydrocephalus is imminent. By far the largest mortality from this disease is amongst infants under five years of age, in whom education has not begun; but it is a significant fact, to which attention has not hitherto been directed, that during the last ten years, when education has been so much extended, an enormous and disproportionate increase has taken place in the number of deaths ascribed to it in the education and post-education periods—that is to say, from five to twenty-five years of age. In 1868 the total number of deaths registered as due to acute hydrocephalus was 7,184, and of these 6,185 were of infants under five years of age, and 1,062 of children and young persons from five to twenty-five years of age. But in 1879 the total number of deaths registered as due to acute hydrocephalus was 8,158, and of these 6,438 were of infants under five years of age, and 1,666 of children and young persons from five to twenty-five years of age. These facts, surely, suggest that against the benefits which we are deriving from education must be placed some detrimental results, and that mental cultivation and brain stimulation are sometimes pushed too far for health. Individual cases, too, reported in medical journals and works, put it beyond cavil that acute hydrocephalus may be set up by school tasks too severe either in themselves, or relatively to the capacity of the child. The children predisposed to the disease are, for the most part, obedient and anxious to please. They do not complain of the grievous burdens laid on them, but they gradually lose their vivacity and cheerfulness, assume a melancholy and subdued appearance, or become fretful without cause. Still toiling on, they avoid bright lights, and shrink from loud noises, experience transient attacks of giddiness, and take longer to their lessons than they were wont to do, and yet make less progress. Next come modifications of appetite, which is sometimes voracious and sometimes altogether lost, and impairment of nutrition marked by some emaciation and failure of muscular strength. And at this stage, if not earlier, there is headache, pain either sharp and causing cries, or dull and subdued, in some part of the head, and often accompanied by vomiting. Among other premonitory symptoms which show themselves with greater or less frequency and in many combinations may be mentioned taciturnity, or unaccountable outbreaks of irascibility, flushing of the face often in patches, squinting, contraction of the eyebrows, acceleration of the pulse, especially towards evening, and febrile disturbance, with exacerbations and remissions at irregular intervals, and constipation of the bowels. The course of the disease need not be further traced, but this may be mentioned, that where it has been brought on by school work the little sufferer will babble in his delirium or broken sleep of the cruel tasks which have undone him. A boy of twelve raved over the Latin grammar, over which he had spent so many weary hours, and a little girl of eight, who was under the care of Dr. Cheadle for a week before she fell into her last sleep, and when she knew not those about her, was constantly and piteously reiterating that her lessons were too hard for her.

Whenever any of the symptoms that have been enumerated appear in a schoolboy or schoolgirl, medical examination is urgently needed, and not a cursory examination, but a thorough and searching one, with exploration of the eye by the ophthalmoscope and of the ear by the speculum, for in these may often be detected early and sure signs of insidious mischief. Each of these symptoms separately, and several of them together, may arise from trifling ailments that need give no anxiety, but the greater the number of them that is found in combination, the more cause will there be for alarm. Any one of these symptoms should lead to a suspension of school work for a time, and to a scrupulous limitation of it to an easily supportable amount when it is resumed. Indeed, with scrofulous children generally, belonging to families in which scrofulous disease has appeared, or themselves presenting indications of the habit, too much forbearance cannot be displayed in regulating their school work, and in exempting them from everything that is burdensome in lessons, or that will interfere with superabundant rest, and ample exercise in the fresh air. Such children must be held back and kept childish, and never spurred on or made old-fashioned. And precautions not less stringent than those recommended in the case of scrofulous children ought always to be taken in the case of children who are not known to be scrofulous, but are simply delicate, for some time after their recovery from any acute disease, for tubercular meningitis, and several other organic and functional diseases of the nervous system, are peculiarly apt to occur, even in those not strongly predisposed to them, after whooping cough, measles, and several other febrile complaints. There is, it must be admitted, a strong temptation to resume education prematurely in children convalescing from acute diseases. They look, perhaps, rosy and well, increase rapidly in stature, and exhibit a keenness and vivacity that augurs well for their profiting by instruction and making up for lost time. And yet their strength is but weakness and their labour vain. Their quick flow of thought is the incontinence of debility, and not the healthy activity of true vigour, and resembles those exaggerated reflex movements which we witness on tickling the soles of the feet or striking the tendon below the kneepan, when there is descending degeneration of the cord and augmented excitability of grey matter. There is, in fact, increased excitability of certain tracts of grey matter in the brain; a state verging on the morbid, which tends to subside if left alone, but which ends in great mischief if aggravated by enforced exercise. Indeed, under no circumstances does the nervous system require more careful watching and tending than during convalescence from acute diseases. Subsequent to an attack of diphtheria, when it is thought that complete recovery has taken place, the little patient occasionally becomes pale, complains of pain in its joints, loses power over its limbs and muscles generally, so that it cannot sit upright, and sinks into a state of indescribable weakness, in which vision is impaired, the sensibility of the skin diminished, and mental power interfered with, until scarcely a ray of intelligence remains.

After typhoid fever, when it has been severe, a species of imbecility often supervenes, in which may be noted loss of memory, dulness of perception and understanding, and delusions of various kinds. Among the *sequelæ* of whooping cough convulsions must be included, and these sometimes establish themselves, and recur as epilepsy during the remainder of life. These, however, are diseases which demand, and are certain to receive, medical attention and treatment. But there are other states of the nervous system, occurring after acute diseases, which are not recognised as morbid, but which are of great significance as regards their morbid tendencies, and which, if neglected, may lay the foundations of permanent disability or bad health. Of these, the most important is irritable weakness of the nervous system, which no child, emerging from an illness involving fever, is altogether free from, but which children of nervous temperament and hereditarily predisposed to nervous affections suffer from in the most marked degree. This state is signalised by very varied symptoms in different individuals, among the most frequent of which are pallor of the skin, with dilatation of the pupils of the eyes, headache, giddiness, restlessness, irritability of temper, sudden startings or twitchings of the muscles, tremblings and emotional inconstancy, shyness and boldness, or laughter and tears, strangely and unaccountably succeeding each other. It is scarcely needful, however, to look for signs of this state. Its presence may be presumed in all children during convalescence from acute complaints, and prolonged precautions against the evils which may accrue from it should be taken in the case of children of the more nervous sort. And of these precautions, rest is the most important. Nervous centres in a state of irritable weakness should be but sparingly exercised, and never, by any chance, subjected to strain.

Imbecility of mind has been known to come on insidiously in children sent to school work soon after fever and small-pox, when there was no reason to believe that these diseases had caused any inflammation of the brain and its membranes, and otorrhœa and epilepsy have also developed themselves under the same circumstances. Attacks of violent maniacal excitement have been observed in youths resuming occupations implying brain toil when only convalescing from acute illness. But the most frequent pernicious effects of mental exertion, while the brain is in the mobile and impressionable post-febrile state, are not so readily recognised. We can at once decide whether muscular atrophy exists, for we can contrast the suspected group of muscles with the corresponding group on the opposite side of the body, or with the same group in healthy persons of similar muscular development; but it is often difficult to say whether mental atrophy exists, for we have no access to similar standards of comparison. And thus a certain feebleness of some faculties of mind, a certain limitation of mental power, may be induced by premature exertion in the post-febrile state which it may be hard to distinguish from natural inferiority of capacity. A child by brain endowment destined to become a clever man may be dragged down from the career to which it was entitled, and sent on in the way of being a stupid man without the degradation being detected. And this it is which perhaps most often takes place when certain groups of brain cells in the irritable weakness of the post-febrile state are set to work when they ought to repose and feed. They atrophy to some extent, and over a larger or smaller area, and leave some slight intellectual defect, or some change of character behind them.

There is still another state of the nervous system in the young in which not less caution and indulgence in educational matters are necessary than during the post-febrile state, and where scrofulous tendencies exist, and that is the state which is found after injuries of the head. In savage races the young brain can apparently bear with impunity considerable physical injury; for among the Chinouks, and other North-American Indians, it has long been the custom to deform the heads of infants by the strapping across them of boards, which are gradually tightened till the desired degree of flatness is obtained; and yet it appears on abundant testimony that this severe operation, under which the integuments often slough, while the eyes appear as if they were starting from their sockets, and by which the brain is forcibly displaced and misshapen, exerts no prejudicial effect on the intellect of those who are subjected to it. The flat heads are thought to be superior in shrewdness and practical ability to their brethren whose skulls have not been tampered with, and invariably take a leading position in their tribe. But in civilised races, with more highly-elaborated brains, any such application of pressure to the infant's head would inevitably be fatal. Far less severe pressure only temporarily applied is exceedingly destructive. The compression of the head by the forceps during instrumental delivery has caused incurable idiocy, and blows and falls on the head are a fertile source of brain-disease throughout infancy and childhood, and indeed throughout life. A mere shaking or concussion of the brain may irreparably damage it or alter its constitution. The jar of concussion, it is alleged, has occasionally had a curiously beneficial effect. Dr. Pritchard was informed, on good authority, that there was a family consisting of three boys, all idiots, one of whom received a severe injury to the head, after which his faculties began to brighten up, so that he became a man of good talents and a barrister, while his brothers remained in their idiotcy. Grétry tells us of himself that he was indebted for his musical genius to a violent blow inflicted on his head by a falling beam of wood ; and Petrarch intimates that Pope Clement VI. found his memory wonderfully strengthened after receiving a slight concussion of the brain. But in nine hundred and ninety-nine cases out of a thousand the effects of a blow on the head, when any effects are discernible, are anything but invigorating, and the brain cannot be too jealously guarded against concussion. No injury to the head in the young is too slight to be worthy of notice, and special vigilance is demanded for a season after any severe blow or concussion, even although it may not seem to have done any permanent mischief. The dropping of infants, and the knocks that their fragile skulls receive in the reckless tossing about to which they are sometimes submitted, are responsible probably for a considerable amount of infant mortality. A fall or a blow about which nothing has been said would often doubtless account for mysterious convulsions and attacks of brain disease. In older children the connection between cerebral injury or concussion and actual brain-disease is less likely to be overlooked, but some insidious consesequences of blows on the head are still liable to be misapprehended. A blunting of faculty and disinclination for school work, which, from having been a pleasure, becomes a drudgery, following within a few weeks of the blow of a cricket-ball, which stunned for a few seconds, is much more likely to be attributed to idleness than to its true cause—namely, a state of the cerebral molecules, induced by violent vibration, unfitting them for the complete performance of those changes that correspond with the reception and assimilation of learning. Momentary attacks of giddiness, with pallor of the countenance, succeeding, after some interval, a fall on the head in the gymnasium, are more likely to be referred to the stomach than to the instability of a brain area set up by shock. And yet the recognition of the true nature of these states and of others allied to them is of great moment, for if improperly treated they are prone to pass into grave disorders. And in all morbid nervous states due to a brain-shake, rest is of the first consequence. The cells that have been agitated by collision are not up to much work, and their functional activity will be seriously compromised if they be compelled to go through even their accustomed modicum of duty. It is a wise measure, and a saving of time in the end, always to insist on a long holiday after a concussion of the brain or violent blow on the head, and to see that at the end of the holiday work is resumed very gradually. A neglect of this precaution may entail life-long deficiency, or a sad deterioration of moral character. A master of a public school, who had given some attention to this subject, told Dr. Farquharson that a well-marked difference is often seen as they grow up in boys who persevere with school work after head accidents at games. He had over and over again remarked that the fine edge and keenness of talent was worn away in those who worked on after suffering from the rough usage of the playground. A boy who was knocked over by a cricket-ball, which struck him in the forehead, but who did not complain much at the time, rapidly lost his place in class, and was noticed to be extremely stupid before the end of the term. His autumn holidays brightened him up, and he returned to school in good spirits, and commenced work with his old energy and success. But he very speedily fell off, being distressed by constant headaches, and becoming thin and pale. He was sent home, and remained there until after the Christmas holidays, when he again attempted to take up his studies, but with the same result—immediate failure in intelligence and health with prostrating headache. It was not until he had enjoyed another six months of absolute rest in the country, with appropriate medical treatment, that he was able to undertake his school work with impunity. "It is nearly always true," says Dr. Clifford Allbutt, "that a case of brain exhaustion needs what may seem a disproportionate time to get well. Repair in so delicate an organ is slow, and we know that gardeners and breeders would rather start afresh with young stocks than nurse round specimens that have been checked."

But where there has been no cranial injury, no acute disease, and where no tubercular tendencies exist, brain forcing or burdensome school work may still cause physical disorder, less grave than acute hydrocephalus, but still well deserving of attention. Headaches, it is alleged, are now produced on a large scale in schools. A German physician, Dr. Treichler, raised a note of alarm on this subject three years ago, asserting that habitual headache, due to intellectual over-exertion enforced in schools, had increased both in boys and girls, and that this headache not only destroys much of the happiness and cheerfulness of life, but produces impoverishment of the blood and loss of intellectual tone, and reduces many a highly-gifted soul to a humble level. Inquiries made at Darmstadt, Paris, and Neuenburg, go to prove, he thinks, that one-third of the pupils attending school suffer from it ; and his researches leave no doubt that it must be ascribed to intellectual overloading of the pupils in their being compelled to take up too many subjects and engage in work at night, when the ganglion cells of the brain are exhausted. Dr. Treichler's conclusions have not been received as applicable to this country, where nothing like one-third of the pupils attending schools suffer from habitual headaches, and it has been suggested by Dr. Henry Bennet and others that the frequency of school headaches in Germany and France must be attributed to the defective ventilation of the schools in the two countries, and to the breathing of a contaminated atmosphere by the children. Still, evidence is not wanting that headaches are increasing amongst children in this country attending schools where methodical and effective ventilation are carried out, and such headaches can only be traced to the incidence of intellectual work upon brains of low educability or badly nourished, and so easily fatigued and exhausted. Headaches in children used to be rare, and were regarded as almost always importing organic disease of the brain, but they are now of daily occurrence, and may be neuralgic, as when they are limited to one side; hyperæmic, due to congestion of the brain; anæmic, due to brain starvation; and toxic, or dependent upon the presence of pernicious matter in the blood. Whatever their cause, headaches in children merit instant and close attention, and their study may lead to amendment of our educational arrangements in various directions.

There is one special kind of headache that children may suffer from that must be separately mentioned, because its occurrence might cause unnecessary alarm to those who are charged with the guardianship of the nervous system in the young, unless its nature was understood. This is megrim, or sick headache: an almost startling but not truly dangerous disorder, which is very often brought on by injudicious application to study, especially at three periods—the second dentition, puberty, and early adult life, in those predisposed to nervous diseases. It is essentially a paroxysmal and periodical nerve storm, affecting certain portions of the nervous system. To call megrim a nerve storm is not merely to speak figuratively, for there are good grounds for holding that it really depends, not as has often been supposed, on disorder of the stomach, liver, or bowels, or on disturbance of the circulation, but on an innate vice of certain nervous tracts imparting to them a tendency to the irregular accumulation and discharge of nerve force. The immediate antecedent of the attack is a state of gradually increasing tension and unstable equilibrium in the nervous tissue involved, and the paroxysm itself may be likened to a storm by which the pent-up energy is dispersed and equilibrium for a time restored. Of course, the features of the storm will depend in great measure on the focus in which it originates and the course it pursues; and as the foci and circuits of nerve storms are numerous, the symptoms characterising them are various. The most common of these, however, are headache, often of a very intense kind, often limited to one side of the head, giddiness, nausea and vomitings, transient loss of vision, dazzling or dark spots before the eyes, or the appearance of zigzag or fortification outlines, with luminous or bright-coloured angles and in perpetual oscillation, one-sided numbness and tingling especially in the hands, impairment of the powers of speech, and confusion of thought. Such phenomena occurring suddenly in a previously healthy child are not infrequently taken to signalise some organic disease of the brain. Fortunately, however, the attacks of megrim are not of long duration, rarely lasting more than a day, so that the anxiety is not long-lived, while time is not allowed for much heroic treatment. Of course, misunderstanding as to their true character can only arise during the first or second attack, as when their periodicity is once established they can scarcely be mistaken for anything but what they are.

The great engine by which that brain-forcing system, some of the painful consequences of which have been considered, operates is examination, which in these times is of two kinds: low-pressure, or qualifying; and high-pressure, or competitive. Both of these are powerful artificial stimulants to brain-work, and both of them have manifest advantages and serious drawbacks, which will some day have to be balanced against each other. In the meantime, however, it is not to be hoped that examinations can be got rid of; but, perhaps, something may be done to mitigate their evils and to prevent their extension in certain directions in which they would be peculiarly noisome.

The competitive examination system, which originated at Cambridge not so long ago, has now insinuated itself into every branch of the public service. The facility with which it can be carried out, the escape which it affords from the embarrassments of selection, and the scandals of nepotism, the fairness with which it throws open rewards to the meritorious of all classes of the community, and the belief which has grown up in the exactitude of its results, have firmly established it in public favour. And yet it might well be questioned whether it is entitled to the encomiums bestowed upon it, and the faith reposed in it. The hap-hazard element enters into it much more largely than is supposed, and the Rev. A. R. Grant, a most trustworthy authority on such a subject, has written, "In practice, so far from any given total of marks representing absolute merit, I believe that no one who knows anything practically about examinations will deny that in a dozen different examinations of the same candidates by the same examiners, and in the same subjects, it is highly improbable that any two lists would give exactly the same order." Arguments founded on the results of the system, and the quality of the men whom it has provided for the various services, at the portals of which it is employed, need not count for much, as, however good or bad these men may be, it is impossible to deny that they might have been better or worse if selected in any other way. But a just estimate of the value of competitive examinations may be formed by a consideration of the limits of their powers as tests of knowledge and capacity, by an acquaintance with the kinds of preparation for them that have been established, and by a study of their effects on some of those who have undergone them. Now it is clear that examinations at the best can only put to proof memory and the power of ready recollection, and that they cannot gauge capacity of mind or force of character. A nimble trickster may succeed under them, when the strong man with the genuine staying power fails lamentably. A small shop with a large frontage may make more show of its meagre stock than a vast but unpretending warehouse of its ample stores of rich merchandise; and so a quick-witted superficial man, with the tact to make the best of his slender acquirements, may excel in an examination over a sagacious deep-thinking man, who is slower in reproducing his knowledge. The tendency of such examinations is to make ruffles the measure of shirt, and to prefer alertness to strength of mind. They secure, it may be admitted, a high average of talent; but they exclude a valuable type of mind—that which is powerful and capacious. And in this aspect of competitive examination, it must be observed that the earlier the age at which they are resorted to, the less satisfactory will be their results. It may be practicable, with some approach to exactitude, to classify a number of adult persons, with fully-developed minds, by their answers to a series of questions upon various subjects; but it is absolutely impossible by any such process to determine the relative value of the ultimate endowments of children of tender years with minds still largely undeveloped, and actually undergoing germination at very different rates in different regions. The fallacy of schoolroom predictions, whether for good or evil, is being illustrated every day, and the notion that the fruits of manhood can be foreseen in the written exercises in callow youths is simply absurd. It may be laid down as a rule that competitive examinations diminish in value as tests, even of memory, steadiness, and industry, in proportion to the youthfulness of those to whom they are applied, and that the risks attending them increase in an inverse ratio. The recent extension of the competitive examinations to the selection of naval cadets is, therefore, to be much deplored. The candidates for these appointments must now be not less than twelve nor more than thirteen and a half years old, and having been found physically fit, on medical inspection, they are to be subjected to examination in arithmetic, algebra, geometry, English, French, and Scripture history, with the addition of two out of another list of more advanced subjects. Now, will any one knowing anything of boys believe that by such an examination the sort of material will be obtained that is wanted in the Royal Navy? The boys who at the early age indicated excel in these subjects will be either precocious—and precocity, we have seen, means either delicacy or an early arrest of the premature mental development—or the products of a system of cramming that is not unlikely to stunt their growth and dull their faculties. Of a number of boys from twelve to thirteen and a half submitted to competitive examination of this kind, those with the best mental powers would certainly not obtain the highest marks. Much faculty is still potential at that age, and is not to be measured by any questions that can be devised in the subjects enumerated.

As regards mere intellect, the Navy examination will not supply the material that is wanted; but what guarantee will it afford of those moral qualities that are not less desirable than intellect in a naval officer? How can it test courage, fortitude, energy, decision, the power of swaying others? Competitive examinations can never report faithfully or at all on such traits of character, and it is to be feared that they have themselves some slight tendency to demoralise all those who have anything to do with them. The teacher who has to prepare pupils for them is tempted so to teach, not that the pupils may grow in wisdom, but they may know, and get marks. The desire to be thorough is supplanted by the desire to see his pupils through, and so he falls, in some degree, from his high calling. And, as for the pupils, they must inevitably contract some obliquity of moral vision, when they get up only parts of subjects given out, in accordance with hints from their crammer, or commit to memory answers to questions on subjects which they have not attempted to get up at all.

The competitive examination system necessarily involves cramming, which is special preparation for a special purpose, and has many objectionable aspects. It is destructive of sound education, for it takes up the time which should be devoted to it, and it substitutes for a sober and orderly development of all the faculties and capacities a very partial training of one or two powers. It is practically useless as a mental discipline, and even as a mental feeder; for it may be doubted whether the information acquired during cramming is retained long after the ordeal in which it was intended to be serviceable. That information is acquired in far too hurried a way, and no time is allowed for its complete registration in the mind, so that it shall ever afterwards be available for reference. Facts are crowded in on facts, and mental digestion and assimilation are out of the question. And the whole process of acquirement is carried on under worry and excitement that render impossible the concentration of attention upon it. Purely intellectual efforts if excessive may, as we have seen, be prejudicial to health, and particularly in the young; but at all ages the intellectual effort that is accompanied by emotional perturbation is peculiarly hurtful. The longevity of those who follow intellectual pursuits, it has been shown, is just in proportion to the degree in which feeling mingles with these pursuits. The mathematician and rational philosopher, living in a serene, dry, cold, intellectual atmosphere, above the storms of passions, see length of days; but the poet and the painter, moving in the hot, humid, and tempestuous regions of emotion, find comparatively early graves. And so the student who works with calm deliberation for the sake of intellectual advancement does so with immunity from many of the pathological risks which beset him who toils at his book in feverish haste, now flushed with the hope of triumph, now pale with the terror of imminent disgrace. It is this emotional element in all preparation for competitive examinations that causes such wear and tear in the nervous system, and conduces principally to many of the disasters for which they are responsible—to suicide or mental derangement, to broken health or shattered nerves, intemperate habits, or an insurmountable disgust with knowledge and intellectual culture. The high nervous tension depending on the combination of hard mental labour with anxious forebodings sets up, in some cases, indigestion, which may be a life-long harassment; and in others sleeplessness, which is relieved by the use of narcotics, which may be the destruction of a promising career. It is upon the most sensitive and refined—the nervous and conscientious—that competitive examinations exert their worst effects. They, together with the men who have had strong predilections for particular lines of study, and who have not paid equal attention to every subject of instruction, break down and fail, while more stolid and stupid men, not easily agitated and capable of a dull routine of cram, hold on and succeed.

Against pass or qualifying and school examinations, many of the objections offered to competitive examinations cannot be urged. It is, of course, needful that it should be ascertained that profit has been derived from instruction and a certain moderate standard attained, and it is also desirable that all who are undergoing education should be exercised in reviewing their acquirements from time to time. But even school examinations may become baneful if made objects in themselves, or if the preparation for them is too severe. In the case of girls, in whom emulation is generally intensely active, examinations must be very jealously watched. In many girls' schools prizes have been abolished because they were found to involve a dangerous strain; but so inveterate is the practice of stimulating by rivalry in education that where prizes have been nominally dispensed with they have been re-introduced under the thin disguise of marks, which are practically symbols of prizes, and which the girls soon come to strive for as eagerly as they would for a book or medal.

The epidemic of examinations which has overrun the country deserves a fuller consideration than can be granted here. It threatens to defeat all the objects of those who have been most zealous in advancing education, for it must, if unchecked, blight all true education; while, at the same time, it cannot fail to make serious inroads on the health of the people. Educationists are, for the most part, prejudiced on this subject, and regard as a panacea what is really a subtle poison; so it is for parents firmly to discountenance the great and growing evil, and to protect their children from its attacks. Better a backwoodsman in his solitude and privation, so that he has broad shoulders and sound digestion, than a senior wrangler with all his blushing honours thick upon him, but with the addition of a round back and an incurable dyspepsia. Happiness goes with health, which, in its widest sense, is man's chief end, for he only who possesses it is able "to glorify God and enjoy him for ever."

MORAL EDUCATION.

A sound intellectual education in general exerts a certain moral influence on those who have had the benefit of it. It cannot be said that all intellectually well-educated men are virtuous, nor that even high intellectual attainments deter from vice—for in Pope, Savage, Marat, Turner, Diderot, and many other illustrious men who might be named, we have had exemplified the association of exquisite culture with immorality and degradation. But still on the large scale it holds good that knowledge is protective against corruption of manners, and that, as an old preacher put it, to fill the sack with wheat betimes is "the best way to prevent the devil from filling it with tares." Lord Derby said some time ago that as Chairman of Quarter Sessions he had had to deal with 1,500 offenders against the law, and that nothing had struck him more forcibly than the utter stupidity and brainlessness of ninety-nine out of every hundred of the prisoners who came before him. It was not merely ignorance: that might be explained by their belonging to the poorest class; but they were for the most part as much below the average of their own class intellectually as they were morally. Nine out of ten of them might have been Zulus for any good they have got from civilisation, and that, Lord Derby thought, was a sufficient answer to the foolish talk sometimes heard about the worthlessness of merely intellectual education. Civilised beings will not at least have the vices of savages or of brutes. Any one, recalling acquaintances he has met in his life journey, will perceive that those of them who have fallen into evil courses were not the men who had a turn for books or study. To give men wide and varied interests, resources to turn to outside their bread-winning occupation, glimpses into time and space, or even the humble power of reading, writing, and casting accounts, is in some degree to lift them above base temptations. There is, as we have seen, unity in diversity in the brain and connections so intimate and intricate of part with part, that it can scarcely be strengthened in one region without being coincidently reinforced or modified in others. We can understand, therefore, how the cultivation of the intellect alone may tend to control or inhibit immediate impulse, and to impress habits of order and industry upon all the mental activities.

But intellectual education alone is insufficient to insure virtuous living and conformity to a high standard of morality. It restrains from coarse crimes, but is impotent as regards polished vices. It raises men above temptations of the baser sort, but it also opens out before them prospects of pleasure and enticements to wrong-doing that are unknown to those who wallow in the mire of ignorance. The multiplication of social wants, which accompanies high civilisation, leads to manifestations of fraud, bad faith, and selfishness that are unknown in ruder times when violence abounds.

The inadequacy of what is commonly understood as intellectual education to insure good behaviour in life might be inferred from the date at which it begins, for the foundations of character are laid down before any attempt is made at formal instruction. No doubt the motives of conduct are perpetually undergoing variation, and the finishing touches are only given to character in mature years; but still it is true that the moral bias is imparted to life during infancy and childhood. Then it is that inherited imperfections may be diminished by wise management, that habits of truthfulness and justice may be moulded, that principles may be inculcated and ideals created which shall ever afterwards guide and inspire. While the infant is acquainting itself with the properties of the physical universe, it is learning the rudiments of the self-regarding virtues; and while the child is experiencing the sweetness of family affection, it is having its first introduction to the social sentiments. The powerful and far-reaching influence of the association of ideas and feelings at these early ages is generally recognised. In manners—which are of course an expression of a certain nervous organisation—it may be seen in the niceties of good breeding, which under all viscissitudes of fortune cling to those who have contracted them as children in a refined domestic circle; in conduct, it may be detected in the incorrigibility of those who have been reared amidst squalor and wickedness. "The experience of all persons," says Dr. Mouat, "engaged in aiding pauper children to emigrate, and the rules for boarding out, show that it is useless to attempt to correct bad habits and to form character after ten years of age."

The burden and responsibility of moral education, it thus appears, rest with parents; the true school of morals is at home. There is, if we may so say, a pre-established harmony between the parental and the filial mind, and this it is that constitutes, or ought to constitute, the parent the aptest and most sympathetic guide to the nascent faculties of offspring—the mother in the earlier, the father in the later, periods of growth. In the progress of civilisation and division of labour, it has come about that much of education which naturally devolved on the parent has had to be deputed to others, and the tendency has been and is amongst the affluent classes, more and more to hand over the care and training of children to mere hirelings. Monthly and wet nurses, Kindergarten and nursery governesses, schools and colleges, tutors and companions, have relieved fathers and mothers of many old-fashioned duties and obligations; and the amount of intercourse taking place nowadays between parents and children in the higher grades of society is really very limited. And, of course, the middle classes are prone to imitate the manners of the aristocracy, and so amongst them it has become the custom to send boys and girls to boarding-schools to acquire those graces of deportment and intellectual attainments which are apparently not to be had at home. Among the working-classes, again, the conditions of the industries which they pursue, and the necessity often imposed on the mother to labour as well as the father in order that a livlihood may be earned for the family, have inevitably interfered with parental duty, and led to the creation of crèches and "minding schools," while, perhaps, the interference of the State in education has tended to weaken the sense of parental responsibility.

All this is greatly to be deplored, for the sake of parents and children alike. A woman's education can scarcely be said to be complete until she has known the cares of motherhood, and a man is never more truly manly than when he is stooping to help the little ones that bear his name. The frivolous ladies of society, the self-indulgent loungers at clubs, the vulgar philistines of mediocrity, and the hardened and degraded men and women encountered in large towns, are all perhaps suffering in some measure from the deprivation of those tender and refining influences which children diffuse around them in a happy and well-ordered home. And as regards children, the evils resulting from the want of parental affection and help are sufficiently obvious; and, indeed, no greater misfortune can befall a child than to be denied the advantages of family life, and to be reared by strangers. On a wide survey, it will be found that the family and not the commune is the true social unit; and that upon the way in which it performs its functions, the weal or woe of the body corporate must depend. The Scotch have been always distinguished, at home and abroad, as a grave, thoughtful, and provident race; not skilful and dexterous at handicrafts when compared with the dwellers in the south, but honest, faithful, and law-abiding; and it has been the custom to attribute their national characteristics to the influence of their parish schools. These schools, in which for a century and a half the children of rich and poor have met together on an equal platform for the pursuit of knowledge, have no doubt had powerful effects upon the opinions and sentiments of the people. They have helped to convert them from clannish or feudal to moderate democratic principles; they have led even the humblest peasants to make the schooling of their children not less a matter of prospective calculation than their clothing and daily bread. But it may be questioned whether the parish schools are to be credited with the moral traits of the Scottish character. These ought, perhaps, rather to be credited with the parish schools, for their operation may be recognised in the civil and religious history of the country before the parish schools were called into existence. The moral qualities of the Scotch are clearly to be attributed chiefly to the family life of the people, and the strength of their domestic affections. Burns, with true poetic insight, perceived this, for after describing in the "Cottar's Saturday Night" the reunion of the children round their father's hearth, he exclaims:

> "From scenes like these old Scotia's grandeur springs,
> That makes her loved at home, revered abroad."

There has always been in Scotland a high conception of parental duty, and a generally faithful performance of it. Almost universally the children, while attending the parish schools, have lived at home, where they have grown up in what has been for the most part an atmosphere of goodness, reverence, and kindly feeling. They have had before them the examples of gentleness, probity, and justice. They have shared their joys and griefs with brothers and sisters, and in the little commonwealth of home have learned to practice that self-denial which is at the root of true discipline. They have been taught to be proud of their humble lineage, and to be careful to bring no discredit on kinsmen well-placed and respected in the world. They have had the precepts of religion and a simple, wholesome morality engraven on their minds at their most plastic period, and in association with impressions of place and circumstance that must ever remain bright and beautiful in memory. And so when at adolescence they go forth into the world, unless of radically bad and obdurate nature, they are fortified in some degree against temptation, and have a glow of affection within which may help to keep them on the straight path at many a dark turning in life.

Of course, men and women in Scotland or elsewhere learn very variously, and out of an early home-training of penury, contention, and neglect, a strong, upright character may emerge. But undoubtedly the family influences just indicated are those which conduce most decidedly to the formation of a worthy, moral character, and their power in doing this will, perhaps, be best appreciated if we consider what occurs when they are withheld. One of the most scientific of prison surgeons, Dr. Clarke, of Wakefield, states that members of the class from which criminals are mostly drawn are commonly separated from the parent stock very early in life, and in the subsequent struggle for existence, having to fight their way apart, rapidly lose all sight, and frequently all recollection, of even their more immediate ancestors, this being especially true of the Irish, who form a sixth of the prisoners in Wakefield, and who frequently leave their homes when very young, and never see nor hear of their relations again. An able and penetrating writer has attributed the strange warp in the nature of Turner, the painter, and some defects in his work also, in a large degree to the circumstance that, owing to his mother's insanity, he never knew the charms of home life. Granted that the uncancelled traces of the mother's madness wrought in him, still, it must be allowed that "he was terribly handicapped in the struggle for peace and happiness on earth, in his desire for right thinking and right doing, in his aims at self-development, in his chance of wholesome friendship with his kind, in his capacity for understanding others and making himself understood," by never having known a mother's guidance or the refining sweetness of home. In Tattycoram and Miss Wade, in "Little Dorrit," we have what were not altogether fancy sketches, by Charles Dickens, of the moral deterioration of the character of foundlings who have never experienced parental or family affection, and in the singularly interesting and able reports of Professor Laurie on the Educational Hospitals of Edinburgh, we have conclusive evidence of the evil effects of withholding from boys and girls the benign and invigorating influences of family life. These effects are intellectual, moral, and even physical; but as they are chiefly exhibited in the moral sphere, and are produced not by any deficiency in the means of intellectual sustenance, but by the want of healthy, moral influences, they are referred to in this place. The hospitals on which Professor Laurie reports are charitable institutions into which children from seven years of age upwards, possessing certain qualifications of name and parentage, are received, boarded, clothed, and educated free of charge, and from which, at from fifteen to eighteen years of age, they are put out or apprenticed to trades and occupations. A boy or girl obtaining admission to one of these hospitals is looked on as provided for, and until the time of Professor Laurie's inquiry had comparatively little subsequent intercourse with his or her relations. And as regards this system of hospital education Professor Laurie's verdict is clear and decisive: "If monasteries," he says, "are bad for men who deliberately enter them after their characters are formed, how much more hurtful must they be for boys whose characters they form. One cannot," he goes on, "watch the movements and expression of hospital boys while in the hospital or when they leave without missing that which constitutes the chief charm of other boys at the same age and is the ground of our best hopes for them as future members of society. The impression which the boys give is of a negative kind, and the observer longs for a more positive exhibition of life and character. This we desiderate in almost every face. There is a painful monotony of look and air. The fixed hours for every act, the unvarying round from day to day, the necessity of acting in masses, the regimental routine in which every duty is embedded inevitably tend to the destruction of individuality; and where individuality disappears morality is either a habit of fear, or a hard duty which has reference only to external imposition: it loses its root in principles and personality. It has, in fact, no root, it becomes eye-morality, and boys will seek every opportunity of evasion. It will always be well that hospital boys should not encounter any rude shock in their after lives, at least not too soon after breaking the hospital leading strings."

But the monasticism in education which has done so much mischief in the Edinburgh hospitals is not confined to these institutions. Evidence of its detrimental influence, and of the deteriorating action on boys and girls of a secluded life, devoid of little personal interests and cares, of individual attention and cherishing affection, made monotonous by constant depression and dreary routine, might be drawn from many quarters. Mr. Mozeley, Inspector of Workhouse Schools, points out that "The most prominent faults of workhouse boys, being rather of a negative than of a positive character—as indolence, vacancy, stupidity—are such as would be most likely to be cured by a greater freedom of life. . . . . My feeling is so strong of the weakness of character and intellect produced by entire confinement from the outer world that, all danger notwithstanding, I am disposed to approve of a certain measure of freedom, at all events for boys." Mrs. Nassau Senior was painfully impressed by the number of girls who had been educated in industrial schools, and were reputed to have fallen; and Miss Smedley concluded from her inquiries that monster schools send out girls of a peculiarly hard, helpless, and apathetic type of character, presenting a remarkable degree of stubbornness and violence, whereas boarded-out girls present only the usual faults of the class in which they are born. And some of the influence producing such lamentable results in hospitals and pauper schools are operative—in a milder degree, no doubt, but still operative—in all boarding-schools, from the highest to the lowest, and of these the most important is the deprivation of the interests, obligations, and affections of family life. For the bright vision conjured up by the word "home," the hospital boy has only the dreary memory of cold corridors and a long row of beds, and surely to the boy educated at a boarding-school the same word cannot have the full depth of meaning and emotional power that it has for the boy who has been reared at home. Alike at hospitals and boarding-schools, boys are denied the incalculable benefits which they derive from listening to the conversation of their elders, from contact with little children, and familiar intercourse with sisters and female relatives.

In public schools and boarding-schools of the better sort the evils of monasticism are counteracted very effectually in a variety of ways. Routine is broken in upon by the arrangement of study, and by recreations of all kinds. Family associations are maintained by frequent long holidays and unrestricted correspondence. Independence and spontaneity are promoted by the large range of freedom of action allowed, and a feeling of personal responsibility is encouraged by the whole system of discipline. But still it remains true that boarding-schools can never supply a moral education comparable to that which is obtained in refined, domestic life, and that the ideal education for intellectual and moral purposes at the present time would be daily attendance at a public school by a boy living at home under genial domestic influences. The notion prevalent that it is conducive to manliness, self-reliance, and other peculiarly British virtues to cut a boy free at an early age from his mother's apron-strings, and to send him to rough it amongst boys of his own age, has no good physiological foundation. The process of roughing it, especially when there is no smooth haven at home to return to, is often a very painful one, and some boys are permanently damaged by passing through it. The pain is not a thing in itself to be desired, and the advantages which are said to accompany it are very problematical. Manliness comes soon enough, and need not be anticipated by swagger and affectation, and perhaps that is the best sort of manliness which is founded on a delicate regard for the feelings of others, not that which is an expression of blunted sensibilities. It is sometimes argued, and still oftener acted on where the principle is not avowed, that suffering and discomfort are in themselves good things for the young; that unhappiness at school is useful for moral discipline and the formation of character, and horrible stories are told of teachers in times past who acted on this maxim of tyrants—a maxim which is partly responsible for the system until recently in operation in some public schools, a system of despotic government tempered by tradition, and of familiar intercourse regulated by brute force. True it is that virtue cannot perhaps receive its highest polish without the sweet uses of adversity, but the education of trial and suffering is amply provided for in the changes and chances of this mortal life, and to permit gratuitous afflictions is to run the risk of warping, or even breaking, fine-fibred natures, and of hardening those that are of coarser texture. Timid and sensitive boys have been consigned to early graves before now by the barbarities of school-fellows, or have had long sorrowful shadows cast over their after days by broken health and morbid feelings born of the hardships and harsh treatment they have experienced in what is called the miniature world of school—no miniature, surely, as regards the cruelty and injustice that often abound there. "Unspeakable," says Carlyle, referring to his own introduction to school life, "is the damage and defilement I got out of these coarse, unguided, tyrannous cubs, especially till I revolted against them and gave stroke for stroke, as my pious mother, in her great love of peace and of my best interests, spiritual chiefly, had imprudently forbidden me to do. One way and another, I had never been so wretched as here in that school, and the first two years of my time in it still count amongst the miserable of my life. Academia! High school instructors of youth! Oh ye unspeakable!" Bullying has not yet been banished from all schools in this country, and too much caution cannot be observed in keeping delicate and nervous boys out of the reach of its iniquities. The worship of Arnold has led to a wide-spread adoption of his system of trusting to the honour of boys, and that system when worked by men not endowed with Arnold's moral force cannot, of course, secure even the measure of success which attended it at Rugby. Readers of "Tom Brown's School Days" will probably admit that the boys at Rugby, even in Arnold's time, would have been none the worse for a little more supervision than they enjoyed. Thus might Flashman and men of his class have been restrained from their iniquities, and saved from their pitiable fate. But in schools over which an Arnold does not preside, boys should certainly not be left too much to themselves. The savage instincts are strong in boyhood, the sympathetic emotions are undeveloped, and honour under such circumstances must be a treacherous guide. The difficulty is to maintain the requisite degree of supervision without interfering with independence, freedom, and spontaneity; but most medical men will agree that it is imprudent to leave school boys entirely to their own devices out of school hours. To create amongst them a sentiment of *esprit de corps* and personal honour is an excellent work, but to leave them entirely to the guidance of that sentiment is hazardous; for boys are strongly swayed by vestiges of that instinct that leads many of the lower animals to molest and destroy weakly and sickly members of their species, and are thus led to indulge in conduct which, when calmly reasoned with, they would verbally stigmatise as low, debasing, and unworthy according to their own code of honour.

That the monasticism of public and boarding schools for the better classes is not more markedly injurious than it is, and does not, as in the case of workhouse schools, seriously blight subsequent mental bloom, must be attributed also in some degree to the circumstance that boys of these classes are so far advanced in moral education before they fall under its sway. As we have said, moral education commences in the cradle, the development of character being often determined in the very earliest years by the disposition and actions of the mother or nurse. The ascendency of the mother over the child at the earliest period of life is very great, and may be used as an instrument for bending its character in the right direction. The infant is instinctively conscious that it is dependent on the mother for safety and comfort, and in its powerlessness it speedily, if obscurely, recognises that it must trust to her kindness and sympathy, and so is disposed to yield her implicit obedience, and to be strongly affected by her expressions of approval or disapproval. And here is the mother's opportunity for teaching the first lessons of self-control, and for establishing some useful associations.

As has been already indicated, the influence of the mother is the principal agent by which the habit of obedience may be established in early life; but when that is inadequate to secure conformity to domestic law, it must be supplemented by punishment. And with reference to punishment, the important point to bear in mind is that the method of nature in attaching penalties to certain acts that are inimical to bodily welfare must be as far as possible imitated. If the child touches fire it burns its finger; if it handles a knife unwarily it cuts itself; and the impressions produced by these experiences become safeguards to it for the rest of its existence. The consequences of its transgressions, experimentally ascertained to be inevitable and proportionate to the offence, discipline it to the observance of certain rules and the avoidance of certain actions. And so the direct, constant, and just consequences of its moral delinquencies, neither warded off nor aggravated, are the most reformatory penalties that can be connected with them. If the child is defiant of commands it is visited with parental displeasure; if it breaks its toys it has to go without them; if it is unpunctual it is deprived of the gratifications which punctuality would have secured; and thus it is beneficently checked when it goes wrong, and has its notion of cause and effect strengthened and enlarged without any estrangement from those who are in authority over it. This system of moral education by permitting children to feel the natural reactions of their misdeeds is unquestionably most salutary and capable of great development; but it is not, as some have maintained, all-sufficient. Even with reference to bodily welfare, the natural checks which follow promptly on the violation of law are not adequate of themselves for the protection of the child, which would be destroyed before these lessons were learnt were it not that they are anticipated and supplemented by parental interference. And so, with reference to moral welfare more decisively, the natural consequences, which are often remote from the faults with which they are connected, are powerless of themselves to form and correct the character of the child, who would often go irrevocably astray before their teachings were appreciated and understood were it not that they are anticipated and supplemented by artificial inflictions. Mr. Herbert Spencer, the thorough-going advocate of the natural system of moral education, is constrained to admit that scoldings or blows, in which parental anger vents itself—penalties which are, of course, excluded by his natural system—may, under certain circumstances, be justifiable—justifiable in relation to the uncontrollable children of ill-controlled adults. They are, he says, barbarous methods, suitable to barbarous children of barbarous parents. But it is to be observed that the children of even the most highly-civilised parents are at one period of their lives barbarous, and may be accessible only to what are called barbarous methods; nay, it may be said that at one stage of their existence they are simply animal, and can only be taught and disciplined by those methods which universal human experience has found applicable to the training of animals. And it is assuredly in the barbarous and animal stages of child-life, when the mind is incapable of grasping remote consequences, or of being affected seriously by the sentiments of those around, that the foundations of moral education have to be laid down.

"The great mistake I have observed," says Locke, "in people breeding their children has been, that this has not been taken care of in due season; that the mind has not been made obedient to discipline, and pliant to reason when at first it was most tender, most easy to be bowed." "It seems to be a law of human nature," observes Mill, "that the first sensations experienced produce the greatest effects. Education, then, or the care of forming the habits, ought to commence as much as possible with the period of sensation itself, and at no period is its utmost vigilance of greater importance than at first." "Practical education," says Miss Edgeworth, "begins very early in the nursery: the temper acquires habits much earlier than is usually apprehended; the first impressions which infants receive, and the first habits which they learn from their nurses, influence the temper and disposition long after the slight causes which produced them are forgotten." "I find," says Montaigne, "that our greatest vices derive their first propensity from our most tender infancy." But if the germs of vice are to be eradicated, good habits initiated, and virtuous tendencies implanted in mere infancy and early childhood, it is clear that the system of natural consequences cannot be solely trusted to. Misbehaviour is not always followed by disagreeable natural consequences that are capable of interpretation at that early age, and artificial penalties must be employed to establish the all-important association between pain and transgression, and to secure that submission which is of the essence of discipline. To wait for the teachings of natural consequences, would often be to permit the moral nature to run wild, and to entail much suffering which might have been spared by mild but timely punishment of human imposition. It is sometimes argued that we cannot by any fear of punishment win over the inward sentiments, or bend the will, or do more than insure outward compliance; but at an early age outward compliance is closely linked with inward feeling, and to secure the one is in a large majority of instances to induce the other. It is only when the age of pliancy and susceptibility is merging into that of self-assertion, that artificial penalties unwisely used may lead to deceit and perversity; and even at this age, and subsequently, these penalties must still remain useful and necessary in our highly artificial civilisation, wherever natural consequences must be separated by a long interval of time from offences, or where they are of an obscure and involved character. Of course, artificial penalties must tend gradually to become less violent and severe, and less frequent as civilisation advances, but we cannot yet entirely dispense with them. Even now the children of pure-minded and well-regulated parents, with but few bad traits transmitted from ancestors, born into circumstances involving no strong temptations to evil, might be reared safely and efficiently in all moral respects on the natural-consequences system; but it is almost certain that the attempt to train children of criminal descent, and with many congenital imperfections of character, under that system, and that alone, would end in disastrous failure.

If artificial penalties are to be inflicted on children as disciplinary measures, the next question to consider is what these penalties ought to be; and here the vexed question of corporal punishment presents itself, for it is only in relation to moral education that the employment of corporal punishment can now be advocated—the idea that it is an aid to intellectual development being altogether exploded. A tremor of apprehension is not, it is now recognised, favourable to the acquisition of knowledge, nor to quiet processes of thought; and acute physical suffering, while it may deeply impress upon the memory the external circumstances with which it was associated, does not tend to fix there the train of ideas by which it was immediately preceded, nor does it place the brain in a condition favourable to active work. Castigation produces reflexly sudden and powerful contraction of the small blood-vessels of the central nervous system, and it was perhaps through this action that it was in former days sometimes found useful in the treatment of mania. Such vascular contraction, however, is not conducive to the best functional activity, and if carried too far may become morbid. Every cut of a cane or stroke of a rod is a sharp shock to the nervous system. It is, if we might so say, an epileptic fit from without inwards, and a series of such cuts or strokes leaves the nerve centres in a state of exhaustion and debility. Men have died under and after flogging, and in children brain disease has sometimes originated in its effects. A simple fact or external circumstance may be impressed on the recollection by being connected with the pangs of chastisement, and thus there was perhaps some sense in beating the bounds; but a piece of reasoning, like a problem in Euclid, will never be stamped on the mind in this way, and corporal punishment, as an intellectual stimulant or adjunct to teaching, has been discarded by all sensible men. To attempt to enforce attention or preparation of lessons by the infliction of bodily pain, inveterate as the practice is, must be regarded as a solecism in education. But it is in moral training that its use is still recommended, and here there is much to be said in its favour as a means of domestic discipline for young children. The genial author of "Rab and His Friends," the late Dr. John Brown, upheld corporal punishment in the nursery, and spoke of it as "a wholesome and capital application that does good to the bodies and souls of the little rebels, and is far less cruel than being sulky, as some parents are, and keeping up a grudge at their children." The facility of its application, the speediness with which it may be made to follow offences, and the readiness with which it may be roughly proportioned to them, together with constant demonstrations of its immediate influence on conduct, and a traditional or semi-sacred belief in its efficacy, will long enable mild corporal punishment to hold its place in the penal code of the nursery and home. But beyond the precincts of the home and nursery, where it is inflicted under the restraint of affection and sympathy, corporal punishment is not likely to be long retained as a visitation even for grave moral faults, or even in those extreme cases in which other methods of correction have failed. It may be admitted that there are boys of brutish nature who seem insensible to any influence but the lash, and that there are juvenile immoralities so base and degraded that a sharp instrument like corporal punishment seems needful for their extirpation; but still it must be maintained that any benefit which might accrue from its use under such circumstances and on such subjects would be more than counterbalanced by the deleterious influence of its retention as a possible form of punishment on boys of purer and better disposition, and upon those charged with its infliction. To boys of spirit and refinement it is humiliating to reflect that they are liable to what De Quincey calls bestial and brutal punishments, and to masters it is corrupting to be left in possession of such a power over helpless children—"the long baneful licence to inflict pain." Corporal punishment is to be condemned because it degrades the sufferer and diminishes his self-respect, which is so powerful an agent in all moral reformation, because, however equitably it may be doled out, it affects very differently different tempers, and is felt most acutely by those least deserving of punishment; because it creates a feeling of estrangement from the authority by whom it is inflicted, stirs up not infrequently malign feelings, and shuts the door against gentler but more potent influences; because it is apt when tolerated to be abused, and to degenerate in the hands of miscreants into insensate and hideous cruelties; and because it often fails lamentably to exert any good effect. An accomplished and enlightened schoolmaster, Dr. Hime, Head Master of Foyle College, relates how his eyes were opened to the true relations of corporal punishment by reading a series of essays written by the boys in an English school to whom "Corporal Punishment versus Moral Suasion" had been proposed as a subject. The industrious and steady boys—those on whom punishment of any kind was little likely to fall—all strongly supported the claims of moral suasion; but the boys who were noted for their idleness and irregularity were loud in their denunciation of any kind of punishment except corporal. Flog the boys, they urged, as much as you like, but don't lecture them publicly or privately, or complain to their parents about them. This esoteric view of corporal punishment by those actually under its dominion is strong evidence that it is not only useless but mischievous.

The most conclusive argument against corporal punishment, however, is that it is quite unnecessary. Many schools, large and small, are conducted most successfully without any resort to it, and the day cannot be far distant when in all schools in this country it will pass into desuetude. Of course every argument used against corporal punishment in its accredited forms, and inflicted by the recognised emblems of scholastic discipline, applies with tenfold force against irregular modes of its infliction. Blows with rattans and rulers, and boxing of the ears, ought scarcely to require to be condemned, but unhappily cases present themselves from time to time in hospitals and police courts exemplifying the dire consequences which occasionally follow these kinds of chastisement, and proving that they are still largely in vogue. Rupture of the tympanum, concussion or insidious disease of the brain, has resulted from boxing the ears, and incurable injuries, deformities, and disorders from sudden blows given punitively to children.

Of the other artificial penalties made use of in moral education to supplement the natural consequences of law-breaking, two may be referred to in order to be reprobated. These are the deprivation of food, so that the pangs of hunger may be felt—a most pernicious punishment, surely productive of ill-health; and incarceration in dark rooms or closets, so that the anguish of superstitious dread may be experienced—an even worse infliction, not unlikely to bring on epilepsy or St. Vitus' dance. Whatever their behaviour may be, young growing children should have their meals regularly, and should not be half maddened by fright, as poor Jane Eyre was when shut up in the red bedroom in that dreary twilight after her passionate insurrection. Fasting and terror never drove out naughtiness, and if artifical penalties are needful much milder ones should be adopted. The corner and stool of repentance are unobjectionable, scolding in moderation is salutary, and the withdrawal of little pleasures, dainties, and toys may properly be made to emphasise, in a variety of ways, the expediency of obedience and self-control. For older children suitable penalties may without difficulty be devised in connection with a scheme of marks of merit, with private and public reprimands, with impositions, and with the denial of privileges and indulgences. But for children of all ages, the aim should be not to multiply penalties, but to resort to them as little as possible; and, indeed, when judgment, tact, and good feeling are engaged in the management of children, punishment will be but seldom required.

As has been before indicated, punishment or artificial penalty plays but a small part in moral education, which is imbibed from innumerable sources. Contact with parents, superiors, equals, and mankind generally, in the ever-changing scenes of life, is constantly through imitation and the observation of the effects of demeanour and conduct of different kinds, teaching the child what to do and not to do in its social relations, how to conciliate favour and obtain reward, or avoid disapprobation and disagreeable reprisals. To masses of mankind this is the only kind of moral education that is available, and by it they learn to shape their course. But where culture exists, the shortcomings of this moral education are made up, and its lessons concentrated and classified by subsidiary moral training. The parents and teachers have not only to regulate the actions of their children and pupils, to approve and disapprove of what they do, to enforce obedience, punctuality, and truthfulness, but they have to give express moral lessons, having no necessary relation to actual occurrences, but referring to ideal incidents and situations chosen for their illustrative character. And express moral lessons of this kind may be of the utmost utility. The parent or teacher having before his mind a scheme of the cardinal virtues, takes opportunities of recommending them, and of pointing out their relations to individual and social welfare. Much evil is wrought by a want of knowledge; and a clear appreciation of the consequences of certain kinds of conduct, of the advantages of virtue and the dangers of vice, may save many a boy and girl from lapsing into immorality.

Children will always much rather be instructed in knowledge than lectured on virtue, and those moral lessons will best sink into their minds and be most influential over them which come in inseparable union with new and impressive facts. Thus physiological teaching may be made subservient to lessons in all the self-regarding and many of the social virtues—lessons which come, as it were, unsought and insinuate themselves into the mind when it is engaged in other matters. And other channels besides physiology may be used for the conveyance of moral lessons into the mind in this way. Tales, rhymes, and biographies have been thus used from time immemorial, and will always continue to afford facilities for the formation of character by stamping on the mind at a plastic period abiding moral impressions along with interesting ideas. The love of romance exists in all children, and in some to an intense degree; and there is a curious manifestation of it which has not been sufficiently studied and which often puzzles parents in their work of moral education. This may be described as castle building run wild and bordering on hallucination, and leading sometimes to tissues of what are generally regarded as falsehoods, but are really only romantic inventions like those of the novelist. Mrs. Gaskell made a careful study of this state. "Leonard," she says in her pearl-pure *Ruth*, "Leonard (then about five years old) had for some time shown a strange, odd, disregard for truth; he invented stories and told them with so grave a face that unless there was some internal evidence of their incorrectness (such as describing a cow with a bonnet on) he was generally believed, and his statements, which were given with the full appearance of relating a real occurrence, had once or twice led to awkward results. All the three whose hearts were pained by this apparent unconsciousness of the difference between truth and falsehood were unaccustomed to children, or they would have recognised this as a stage through which most infants who have lively imaginations pass." And this stage is sometimes much more prolonged and characterised by much more elaborate invention than it was in the case of Leonard. At an early period of his childhood Hartley Coleridge conceived the existence of a stream which he named "Jugforce" in a field adjoining the house where he lived. "The banks of the stream thus created," writes his brother, "soon became populous—a region, a realm—and as the vision spread in ever-widening circles it soon overflowed, as it were, the narrow spot in which it was originally generated, and Jugforce, disguised under the less familiar name of Equxria, became an island continent with its attendant isles. Taken as a whole the Equxrian world presented a complete analogue to the world of fact, so far as it was known to Hartley, complete in all its parts, furnishing a theatre and scene of action, with *dramatis personœ* and suitable machinery in which day after day, for the space of long years, he went on evolving the complicated drama of existence. When at length he was obliged to account for his knowledge of connection with this distant land, he had a story, borrowed from the 'Arabian Nights,' of a great bird by which he was carried to and fro. Once I asked him how it was that his absence on these occasions was not observed, but he was angry and mortified. His usual mode of introducing the subject was 'Derwent, I have had letters or papers from Equxria.' Nothing could exceed the seriousness of his manner and, doubtless, of his feelings. He was, I am sure, utterly unconscious of invention. A certain infirmity of will, the specific evil of his life, had already shown itself. His sensibility was intense, and he had not wherewithal to control it. He could not open a letter without trembling. He had paroxysms of rage." It is not difficult to see that this romance life of Hartley Coleridge had become morbid—as indeed unrestrained castle-building is apt in very nervous children to do. That was certainly not a healthy state of the brain that existed in Mrs. Jamieson from her tenth to her fifteenth year, in which she lived, as she declared, a double existence—one outward, linking her with the sensible world, the other inward, thronged with imaginary actions, scenes, and adventures, in contemplating which she was often as unconscious of what was going on around her as if she had been asleep. Conditions of this kind require medical treatment; but the phase of romancing and fibbing in the bulk of children is brief, unabiding, and may be safely disregarded. Nervous children with fertile imaginations, worked into feverish excitement, continue for many years to indulge in this kind of fanciful tippling, but more prosaic children are weaned from it when they are introduced to romance literature, and discover how much more prolific of images than their own brains a good book may be. Still more prosaic children never romance at all, but, like Lucy, in "The Mill on the Floss," are uninterruptedly prim and precise.

Besides the romance period of infancy there must be mentioned, in connection with moral evolution, the adventure period of boyhood, an epoch in individual development corresponding with the epoch of chivalry in the history of the race.

The epoch differs greatly in duration in different individuals, and its subsequent effects on mind and character are in some measure determined by the kind of literary nourishment supplied during its continuance. Sir Walter Scott attributed his pursuits and tastes to a considerable degree to the old Border songs and tales which he learnt in his grandmother's house when at this stage of life, and Burns undoubtedly owed to the recitals of Jenny Wilson in his boyhood much of the material that he has woven into "Tam o' Shanter" and the "Address to the Deil." Few boys can hope to make such use of the materials which they acquire during their wanderings in quest of adventure, but most boys may receive a favourable bias from this material if it be of the right sort, so that they may long afterwards be unconsciously swayed by the example of the heroes whom they then learnt to admire. It is of consequence, therefore, to place in boys' hands books of a healthy tone and wholesome flavour, which shall not stint of the wonderful and romantic, but which shall neither convey jaundiced views of life nor sow the seeds of demoralisation. Fortunately, there is now a copious supply of periodical literature suitable for boys of a thoroughly sound nature, while never-failing fountains of pure, refreshing morality are accessible to all in the Waverley Novels. That boy must be strangely constituted who does not derive pleasure and edification from these books.

After literature, the theatre may be adverted to as a possible school of morality for the young, who are always powerfully affected by dramatic representation. Readers of Wilhelm Meister will remember how the puppet show and the theatre not only gave Wilhelm tumults of enjoyments, but contributed largely to his intellectual growth and to the formation of his character; and those who have watched young children at the pantomime will realise how eagerly and earnestly they enter into what is represented, and how powerfully they might be taught from the stage. Our children's theatre, "Punch" and the pantomime, can scarcely be defended as ethically correct, and the French adaptations with which adults are regaled are not calculated to win converts to the gentler life, and are not fit to be seen by unsullied children. But the time may come when the theatre will be recognised as an instrument of moral education, and may be conducted so as to charm and refine, and meanwhile children may with advantage be occasionally permitted to witness one of Shakespeare's plays. The theatre is of course an exciting recreation, so that its effects should be closely watched.

Art and music in their relation to moral training can be but named. That they have always an elevating and sublimating influence on human nature will not be gainsaid, and that this influence may be inestimably heightened by blending them with its earliest associations no psychologist at least will deny. Where there is physical squalor there is generally a moral slum; and the man who has not music in his soul is not the best of citizens. To surround children with beautiful and worthy objects, and to fill their ears with sweet sounds, is to confer on them infinite possibilities of complex memories, æsthetic sensations, and intellectual emotions, which may well help to keep them from baseness, besides soothing and sustaining them in hours of heartache and anxiety. It has been observed in some large workhouse schools that the boys who have been members of the drum-and-fife bands have done well when sent out into the world, in much larger proportion than the boys who have had no musical training. Teaching children to draw puts happiness and knowledge into their conceptions, which ought sometimes to save them from foulness and sinister proceedings, besides enabling them to pursue art in after-life if they have the gift.

Special exercises and disciplines, designed to form the moral character, have to a great extent passed out of use since the Church lost its influence in Europe; but there are one or two of these which merit a word of notice, because of their obvious utility even when viewed from a physiological point of view. Self-examination, from time to time, judiciously conducted tends to confer steadiness of purpose and tranquillity of mind. Ghostly wrestlings, self-probings, and torturings are of course simply demoralising, and are to be firmly discountenanced; but boys and girls emerging from childhood can be none the worse in these restless days for occasionally communing with their hearts in their own chambers and being still. Pythagoras and Cato advised that the doings of each day should be reviewed at nightfall, and a diary containing little jottings of each day's excursion into the world has manifest advantages. The nightly recollection of daily deeds, disengaged from the heat of passion and distractions of the moment, helps towards the appreciation of their real character, and the subordination of egotism. And the process has also intellectual advantages, for it aids in fixing the various ideas that have passed through the mind, and in giving practical command over them. The banking-house that concluded its business when it closed its front door each afternoon, that did no balancing and book-work after its customers had ceased to stand at its counters, would speedily go to ruin. And so the mind that sinks into idleness whenever it is withdrawn from the bustle of life, whenever it is not in company, and seeing, hearing, that takes no stock of its possessions and does not arrange its transactions, runs some risk of insolvency. Benjamin Franklin, when he formed "the bold and difficult plan of arriving at moral perfection," put himself through a regular and complete course of all the virtues in thirteen weeks, and found much benefit from keeping tablets on which he recorded his progress in each. Without recommending any ingeniously laboured plan of this kind to youths and maidens, it may still be advisable to show them how reflection and self-examination may assist to make them what all moral education aims at making them—reasonably self-governed beings.

Volitional exercises or gymnastics may also, like self-examination, be conducive to true moral culture. The training of the will in its muscular sphere is not without an effect on its operations in the moral sphere, and its training in trivial matters undoubtedly strengthens it for action on momentous occasions. To spring out of bed resolutely at the appointed moment, to abstain now and again from some lawful enjoyment, to persevere firmly in some distasteful task, to observe faithfully the small courtesies of social intercourse and the customs of refinement, is really to gain the mastery over self, and to extend the authority of the will. While fasting by the young is not to be countenanced, self-denial may be commended as salutary and conducive to moral strength, which is promoted also by the sports and usages in which courage, perseverance, and generosity are brought into play.

This is not the place in which to analyse the influence exerted by the teaching of religion on morals; but it is impossible altogether to ignore a force which, although the last to appear in human evolution, has done more than all others to ennoble human nature. In the due performance of his duties, personal and social, in the life-long struggle between truth and error, fulfilment and non-fulfilment of the law, man needs every aid that is available, and to deprive him of his religious feelings and hopes would be really to shear him of his strength and leave him bewildered. And it may well be questioned whether these feelings and hopes can ever become sustaining and guiding principles of action if they are not implanted and fostered in early youth. These hopes and feelings must grow for years together before they can attain a high pitch of intensity; and the worship of the ideal must be begun betimes if it is habitually to influence conduct, for the contemplation of the ideal expands the faculties by which the ideal is cognised. Book-worms and pent-up dwellers in towns, who rarely look further than across the street, see nothing in the distance where the eye of the sailor or the dweller on the prairie can discern a variety of objects; and so spiritual short-sightedness comes of exclusive attention to material objects, and this spiritual short-sightedness, like ocular short-sightedness, is especially apt to be induced during the plasticity of youth. There is in religion a powerful emotional element which can, doubtless, be best cultivated in the home and in the place of worship; but there is an intellectual element too, and the danger is that the divorce of religious from other kinds of instruction will gradually lead to the neglect and degradation of the former, and so to the sacrifice of the power that "makes for righteousness," and to which we owe all that is best in our civilisation. It is impossible to undo what has been done—to break up the human and social organisms and commence their construction afresh; and the attempt, either violently or surreptitiously, to abstract from them an element that enters into the constitution of their every tissue can only end in disintegration and decay.

In employing and directing the various agencies of moral culture that are at command, judgment must be used in bringing them into operation at the proper time. Favourable opportunities of forming character must not be lost, but premature endeavours after an impossible perfection must be avoided; for there is such a thing as moral precocity, and moral, like intellectual precocity, may be a manifestation of disease, or may eventuate in weakness. Little saints, like little prodigies, often die of acute hydrocephalus, and what is called "early piety" not rarely ends in late imbecility. Parents should remember that children are not little nineteenth-century men and women, but diamond editions of very remote ancestors, full of savage whims and impulses, and savage rudiments of virtue. They should not, therefore, be disheartened by inveterately mischievous propensities, nor even by serious delinquencies now and then, which growth and good management will correct; nor should they try to put a mask of propriety on the wanton features of youthful animalism. Let them attend to the weightier matters of the law, and leave the mint and anise and cummin alone. Only when grave offences succeed each other with great frequency, and are not amenable to the ordinary methods of correction, should their apprehensions be excited, and then they should at once consult their medical man, for there is such a thing as moral insanity dependent on a disordered state of the nervous system. It is all very well to laugh at kleptomania, but when a previously well-conducted school-boy, under severe educational pressure, suddenly takes to stealing all kinds of useless articles, and goes on stealing after exposure and punishment, and while at the same time he exhibits convulsive movements of the eyeballs known as nystagmus, these movements and the stealing both ceasing at the same time under medical treatment, it would be preposterous to doubt that the propensity to theft is a symptom of a morbid state. When, therefore, an abrupt change of character is noticed in any child, or when precocious and singular depravity displays itself, medical aid should be invoked. Moral insanity most frequently occurs at the age of puberty—in the female, in connexion with hysteria; and then we have fasting girls and ecstatics, and the simulation of disease; but moral imbecility, as it is called, is generally recognised at a much earlier age. Don Carlos, who appears to have been a moral imbecile, was remarkable for falsehood, ferocity, and cruelty, when a mere child. His delight was to cut the throats of hares and other animals, and gloat over their dying struggles. He frequently roasted them alive. He once received the present of a very large snake from some person who seemed to know how to please this vile young prince. After a time, however, the favourite reptile bit its master's fingers, whereupon he retaliated by biting off its head. He was prematurely and grossly licentious. In such a case, even medical assistance is not likely to be of much avail; but it will be more efficacious than mere moral discipline, and will, at least, conduct to a just appreciation of the monstrosity.

THE INFLUENCE OF EXERCISE ON HEALTH.

By James Cantlie, M.B., F.R.C.S.,

Assistant Surgeon and Demonstrator of Anatomy, Charing Cross Hospital.

Introductory—Muscles—Blood Supply of Muscles—Respiration—Muscular Belongings—Effects of Exercise on Muscles—Insufficient Exercise—Over-exertion—Girl's Work and Exercise—Training: its Dangers and its Use—Walking—Running—Jumping—Dancing—Riding—Skating—Rowing—Cricket—Football—First Aid to the Injured—Swimming—Lawn Tennis—Racquets—Bicycling and Tricycling—Other Games—Gymnastics—Calisthenics.

In the earliest times of the human race, when manual labour was the only means of subsistence—when the man tilled the ground, and the woman tended her children or assisted in agricultural labour, to prompt people to take exercise meant only to induce them to do their daily work. In later times, however, and especially in the world of to-day as we know it, the multiplication of industries has placed many classes in such a position, that exercise is something independent of, and has to be added on to, their daily employment. The moneyed class and the employers of labour; the clerk at his desk and the merchant at his counter; the tailor in his crooked position and the milliner at her seam; the printer setting up type from morning till night; the workers, or rather watchers, at manufactories throughout the length and breadth of the land, have one and all forgotten that their lower extremities are meant to carry them about to get their requirements, and that their hands are organs wherewith they are to feed themselves. They have forgotten, through continued neglect on the part of their predecessors, that tilling the ground or following the chase was once the only employment vouchsafed to man, and that every departure from it to a less natural employment may be an intellectual advance, but a muscular retrocession—a social gain, but a physical decline. Such being the case, it is evident that a great change either in the physique, or in the means of obtaining exercise so as to maintain that physique, must have taken place; and when we come to look into it, we shall find that but few of the employments of the present day carry with them a sufficiency of exercise.

The consequence of too closely following the mercantile *régime* of to-day, with its city surroundings and cooped-up belongings, would be that in time physical ruin would fall upon that individual, family, nation, or race which, by the systematic disregard of common-sense teaching and neglect of out-of-door exercise, would propagate disease, and leave a puny, feeble race behind it—a race of people feeble both in mind and body. How many accounts in sacred and secular history do we not meet with of race succeeding race; of the strong driving out the weak; of the nation of braggart sloth succumbing to the hardy children of a less favoured land? Do not these all incite us to consider our own position, and to see what are *our* means of supplying nature's calls for her original habiliments—what are the means by which we are counteracting the ill effects of the artificial lives we lead, and preventing our nation falling into decay? No more interesting subject can be imagined, since it affects each one of us individually, and causes us to look around on our neighbours, and ask, "What am I doing to maintain this body of mine in the state for which it was intended by nature?" In ancient days there was not the same disregard of health as now, and yet the consequences of breaking health laws have been set down very clearly by Moses. But the days of the Patriarchs have gone by, and we are living in crowded, smoky cities, where the laws of health are but little considered, and where we find portions of our race sinking into weakness, physical decline, and guilt, and by and by disappearing to give place to others, whose forefathers have not transgressed, and whose children will flourish even to the third and fourth generations. The truth that the future state of generations coming after us is directly affected by what we eat and what we drink, and how we obey nature's laws, has never been fully brought home to us. Are we then a degenerate race, or, what is more important, are we ourselves leading lives likely to improve or to render weaker the race that will succeed us? That we ourselves are not as a nation a degenerate race scarcely affects the object of this article; but that we are not is to be gathered from many sources: an ordinary sized man can with difficulty get into an old suit of armour; a man of, say, six feet or thereabouts, and proportionately built, can only here and there find a suit that will fit him, even in that emporium of ancient armour, Spain; the English Channel was never crossed by a swimmer until the year 1875; until the year 1877 no human being had been known to leap from the ground, without artificial aid, six feet two inches; until of late years no man had walked 500 miles in a week; and a mile is now run in four minutes and a few seconds.

These and many other instances could be cited to prove that the present race in this country have performed feats that were physically impossible to their predecessors; and, so far as these facts are concerned, prove that there are amongst us individuals not only equal to, but superior, in physique to any in the generations who have gone before us. What then are we doing to maintain this high state of physique, is the question that immediately concerns us. The daily employment of many people entails no exercise, and the hours they have to spend at it prevent any out-of-door recreation. It is sad to think that honest labour often brings with it, now-a-days, illness and misery; that the state of modern society necessitates incessant work by the many, so that every stitch, and every hammer stroke, is only an advance towards the time when the work will have to be surely stopped on account of ill-health: ill-health caused by a state of society which compels so wide a departure from what man was originally intended for. To counteract the evil effects of this artificial life we have at the present day out-of-door sports of all kinds, calculated to attract and benefit the young especially. It is to the consideration of these we would now turn, and try to understand the right and the wrong, and the good and the bad effects of this combination of work and artificial exercise. Before proceeding, however, to the details of these, we must think first what we are going to exercise, and what is the nature of the tissues and organs we call into play. Regarding the bones and joints as passive organs in motion, the three chief factors concerned in motion and exercise are the muscles, the heart, and the lungs. The muscles are the immediate cause of motion; but the heart and lungs are affected by motion, and their increased activity is necessary for the performance of the muscular function. In general terms, every one knows that the muscles by their contraction cause motion; that the heart is the propeller of the blood through the arteries, capillaries, and veins of the body; and that the lungs take in air for the purpose of submitting the oxygen contained therein to the blood, and allow of the exit of carbonic acid gas. These facts must, however, be considered a little more fully, and first let us discuss

MUSCLES.

It is difficult, when first told, to realise the fact that muscle and flesh are the same tissue. Most people have the idea that the two are totally distinct; the flesh of animals being understood to be a tender, juicy, edible tissue; the muscles, a hard leathery tissue, constituting tough meat, and undesirable as food. What, then, constitutes the difference between flesh and muscle? The difference will be found to be, not in the radical basis, as that is in both cases muscular, but in the presence or absence of fat, and the age of the muscle. When an animal is tied up in a stall, the muscles remain soft and relaxed from want of exercise; and when in addition all sorts of feeding and fattening substances are supplied to it, fat becomes deposited in and around the muscles. When, however, an animal has to wander in search of food over hill and dale, to pull a plough, &c., the muscles become hard, and only a small quantity of fat permeates their substance. The age of an animal will also affect the character of its muscles; a chicken affords tender flesh, but an old fowl may be as tough as leather. Hence it is that the tissues of a young and well-fattened animal are called flesh, and those of an old animal muscle.

Take a piece of meat and examine it carefully. It will be found to be composed, not of a homogeneous mass like a jelly, but of masses of red tissue, separated into areas, and at the same time bound together by a fine connecting tissue, yellow or white according as it contains much or little fat. This is spoken of as a connecting, or *connective tissue*, or *fascia*. The areas of red tissue are

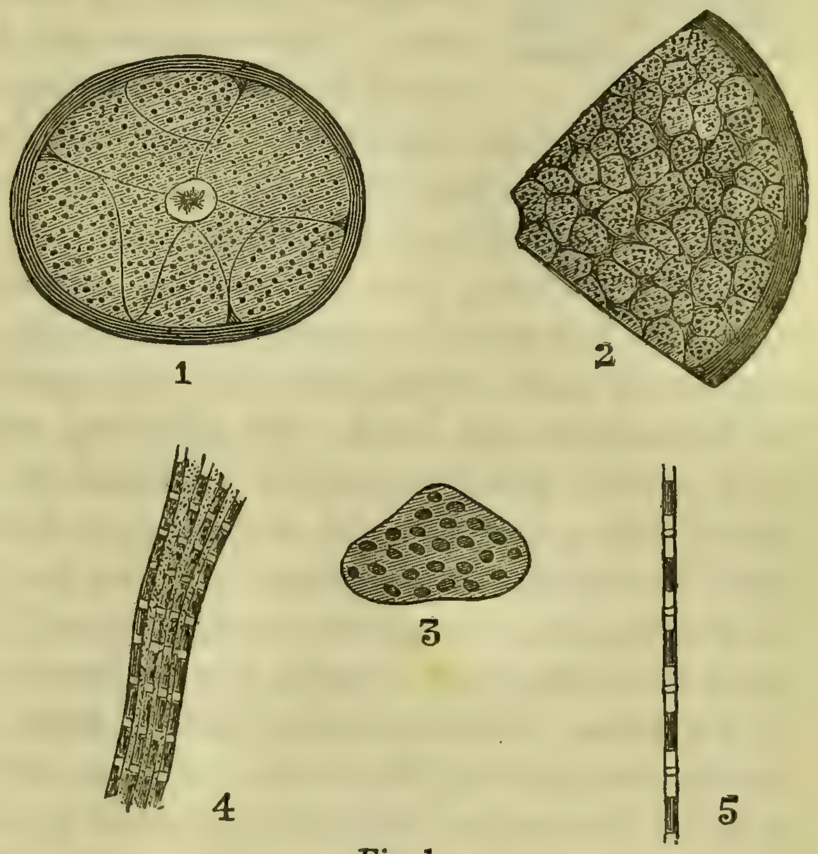

Fig. 1.
1, Diagram of Section of a Limb, showing the Bone in the Centre, the Skin around, and the Muscles, with Processes of Fascia passing in between; 2, a Cross Section of one Muscle, showing the Cut Ends of Fasciculi; 3, a Cross Section of a Fasciculus, showing Fibres; 4, Longitudinal View of a Group of Fibres; 5, Longitudinal View of a Single Fibre.

separate *muscles ;* and in the human body each of these is designated by a separate name, and their function and action have been carefully studied. Take an individual muscle and examine it. Around it is a sheath of connective tissue. From the sheath processes find their way into the muscle substance, dividing it up into bundles (*fasciculi*). A microscopic examination of a bundle (*fasciculus*) would show that it consists of threads of tissue called *fibres*, and that a fibre is itself composed of still finer threads, called *fibrillæ*, or smaller fibres. Fibrillæ are themselves composed of ultimate cells (*muscle* or *sarcous elements*) linked together end to end to form a chain. Resident in these muscular elements is the property of *contraction*, and it is this property that renders muscle the all-important factor in motion. Every one is familiar with muscular contraction ; to illustrate it, let the reader place the right hand over the front of the left arm midway between the shoulder and the elbow ; now flex the elbow—*i.e.*, bring the fore-arm up to the arm. Whilst this is taking place, a hard swelling rises up beneath the right hand, which most people know to be a muscle called the biceps. The cause of its swelling up is that the muscular elements have re-arranged themselves so that the muscle becomes a hard ball, and the effect produced by its swelling up is the motion of the fore-arm. Were one to see the actual elements of the muscle, it would be found that they change their shape during contraction.

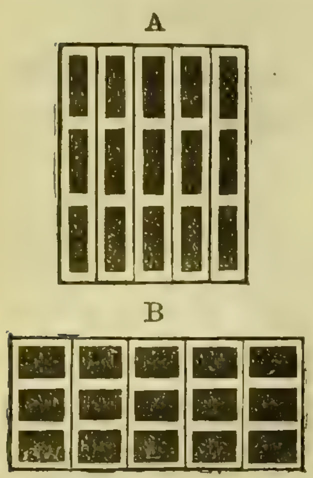

Fig. 2.
A. Muscle Cells, *i.e.*, Sarcous Elements, in a state of rest, with their long axes lengthwise ; B. The same cells in a state of contraction, with their long axes crosswise to the muscle.

The muscles in the link are thick and fleshy in the middle of their course, but at the spot where they cross joints they form, for the most part, hard, dense, fibrous bands called *tendons.* These go popularly by the name of "leaders ;" and at the wrist, where we hear of leaders being so frequently strained, we can feel numbers of hard cords, front and back, passing from the fore-arm to the hand. On following any one of these up the fore-arm, it will be found to be connected with a muscle ; and on tracing it down to the hand, the tendon will be found to go to the bones of the fingers. So throughout the body it will be found much the same, that muscles are connected to bones by tendons. The most fixed point from which a muscle acts is called its *origin ;* and the attachment at which the motion takes place is called its *insertion.* These various points will be more readily understood by reference to the accompanying diagram of the biceps muscle of the arm.

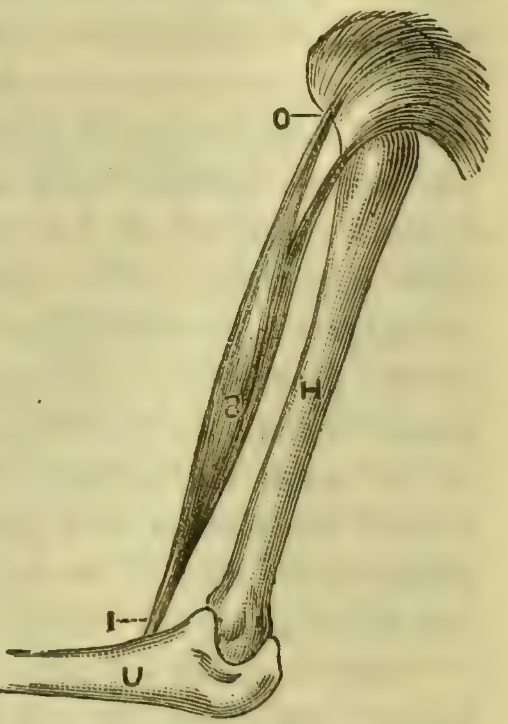

Fig. 3.—DIAGRAM OF BICEPS OF ARM.
H. Humerus, or Arm Bone; U. Ulna, Inside Bone of Fore-arm : the other bone, the "radius," to which the biceps goes, is on the outer side; O. Origin; B. Biceps; I. Insertion.

The mechanical arrangement by which muscles act is that of a *lever.* The alteration in shape, undergone by a muscle in action, is so essentially a vital phenomenon, that change and decay must obviously take place as a consequence. A muscle from prolonged action would get worn out and exhausted, were it not that renewed power is conveyed to it by the blood. It is to the supply of blood to a muscle we must now turn our attention.

THE BLOOD SUPPLY OF MUSCLES.

To fully understand this, let me beg of the reader to bear with me whilst the headings of the circulation are sketched in outline. The chief propeller of the circulation already referred to is the heart; and as most people already know the main facts connected with the circulation, it will be necessary only to point out the relations it bears to the subject in hand. The situation of the heart is known to be behind the breast-bone (sternum) and between the lungs. The heart on examination is found to be a muscle, but differing from the muscles already examined, inasmuch as it is hollow. The cavities in it are four in number, and the walls being contractile like other muscular structures contract upon the contained blood, and send it into the vessels. Valves are placed at the various apertures, so as to determine the course of the blood, and prevent it going back the way it came.

To understand the course of the blood, look at the back of your hand and you will see blue vessels (*veins*) immediately beneath the skin. You may be able to follow one of these up the fore-arm to the elbow, where in front two large veins are found. Grasp now the arm above the elbow, and you will find that the veins stand out more prominently. What does this teach you? It teaches you that the blood in the veins is passing from the fingers up the arm towards the root of the neck, and so on to the heart. In the lower extremities, the veins carry the blood from the toes up the leg and thigh, and finally through the body to the heart. All the blood contained in the veins comes, then, to the heart. The blood contained in them is dark purple, waste or *venous* blood that has been used by the tissues, and is on its way back to the heart. It there passes into the first chamber of the heart (the *right auricle*), and is driven thence, by muscular contraction, into the second chamber (the *right ventricle*). This in turn contracts and sends the blood to the lungs by a large vessel called the *pulmonary artery*. In the lungs the blood is exposed to the oxygen in the air we breathe, and a magical effect is produced. The blood becomes scarlet in colour, purified, as it is termed, and is now ready to go through the body, carrying oxygen to the tissues. It does not, however, go straight from the lungs to the body, but is first collected by vessels called *pulmonary veins*, and is carried back to the heart, first to the *left auricle*, or third chamber, hence to the *left ventricle*, or fourth chamber, and finally leaves the heart by the *aorta*. It will be observed that the two right cavities contain venous blood, and that the two left cavities contain scarlet or arterial blood.

The aorta is the great arterial stem, arising from the left ventricle, which gives off branches (*arteries*) to all parts of the body, carrying pure blood to the tissues.

The use of the blood returning to the left side of the heart from the lungs is to get force given to it from the strong muscular wall of the ventricle, so that it may travel through the arteries in all parts of the body. Each muscular contraction of the left ventricle sends the blood along with an impulse into the arteries, causing the increase in pressure we call the pulse; and a pulse exists in the course of the arteries everywhere in the body. The number of times the pulse beats tells us the number of times our heart contracts, because the one is caused by the other. Hence if we feel the pulse at the wrist, and it beats say seventy-two to the minute, we know that the heart beats, or contracts, likewise seventy-two times a minute. To find the pulse at the wrist, place the fore-finger on a spot an inch above the wrist, and half-an-inch internal to the thumb side of the fore-arm.

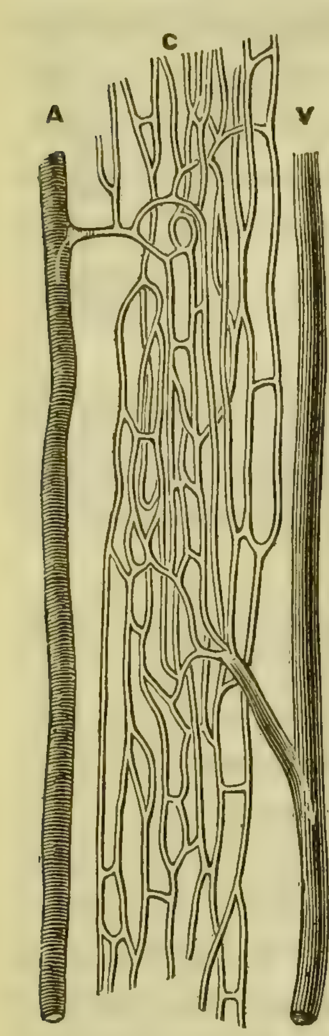

Fig. 4.
A. Artery, giving off a branch to supply C, the Capillary Network within the muscle; V. Vein, being joined by a vein from the substance of a muscle.

Arteries can be felt in many other places; for instance, place your fore-finger immediately in front of the lappet that projects in front of the ear opening, and you there feel an artery, the temporal, beat. Now, the quicker the heart beats the quicker the pulse, and *vice versâ.* Exercise or exertion of any sort increases the frequency of the pulse—*i.e.*, the heart beats quicker. In other words, during muscular contraction (exertion) the circulation of the blood is hastened, necessitating the more speedy contraction of the heart and arteries. Exercise, therefore, increases the circulation.

Muscles are plentifully supplied with blood; squeeze a piece of underdone meat, and the red juice that exudes is seen to be largely charged with red blood. The blood permeates everywhere; arteries carry the pure blood to the muscle, and the veins carry the impure, or venous blood away. In the substance of the muscle, however, finer vessels can be made out by the aid of a microscope, and these vessels being fine, hair-like tubes, are called *capillaries.* These minute vessels are everywhere, one large muscle may contain millions; they are the spots at which the interchange of fluid and gaseous nutrition takes place, as evinced by the change produced on the colour and character of the blood. The blood enters the area of capillaries from an artery, as pure, oxygenated, scarlet, or arterial blood, and emerges in a vein, as impure, dark purple, or venous blood, having lost part of its oxygen, and being charged with carbonic acid. The carbonic acid is now conveyed away to the lungs in the venous blood; and in the lungs the blood gives up the carbonic acid during expiration, and receives the oxygen from the air during inspiration. This leads us now to consider the

Respiration.

Respiration, or breathing, is carried on by the lungs, or "lights," as they are popularly called. The lungs are two large, spongy, elastic bags, placed in the thorax or chest on either side of the heart. Roughly speaking, everywhere you can feel a rib there is lung beneath. Hence, there is lung at the back, sides, and front of the chest. The air enters by the nose or mouth, passes to the back of the throat, hence through the larynx, or "apple in the throat," down the windpipe, and then through the bronchi into the lungs.

The air around us consists, for the most part, of oxygen and nitrogen. The oxygen constitutes about one-fifth part of the atmosphere, and is the active element in maintaining life. The nitrogen, however, we inhale as well, but it is passive in its action, serving simply as a diluent. As the use of breathing is to supply oxygen to the blood and to remove carbonic acid gas, it is evident that the quantity of air required in the lungs depends on the amount of venous or impure blood that is brought hither—*i.e.*, upon the activity of the circulation. As this is in turn largely dependent on the activity of the muscles, it is evident that, during an increased activity of muscles, more venous blood is sent to the lungs, the presence of which necessitates increased rapidity in breathing. The average rate of breathing is, for an adult, from thirteen to twenty times a minute. Women breathe more quickly than men, partly owing to the smaller size of the lung, but mostly to the lower part of the lung being rendered well-nigh useless by the use of stays.

The process of breathing consists of two steps—the taking in, *inhalation*, and the letting out, *exhalation*. What is inhaled is air. What is exhaled are various products from the venous blood. What are these? 1. Water. Breathe on a glass for a time and it will be found to become dim, and by and by drip with moisture; or when the temperature is low, as on a frosty morning, one can "see" one's breath; this is owing to the rapid condensation of the aqueous vapour in the breath, from its contact with cold air. 2. Heat. When our fingers are cold we involuntarily put them to our mouths and breathe upon them to warm them; hence we lose heat by our breath. 3. Carbonic acid gas. When one sits in a room with doors and windows shut, and no fire, the room gets stuffy or close; this is from the presence of carbonic acid gas escaping from one's lungs. A simple experiment proves this. Put some lime-water in a tumbler, and breathe into it through a glass tube: the lime-water becomes milky white; the lime and the carbonic acid gas have united to form chalk. Hence, during exhalation we lose moisture, heat, and carbonic acid gas. As exercise increases the rapidity of breathing, so with exercise the expenditure of each of these factors is increased.

The process of inhalation is chiefly a muscular act, that of exhalation mechanical. The muscles of ordinary inhalation are the midrif (diaphragm), and the muscles between the ribs (intercostals). When, however, extra work is thrown on the lungs, as during running, the breathing is increased, and other muscles are called into play, more especially the muscles of the neck, which after violent exertion stand out like cords beneath the skin. The act of exhalation, on the other hand, is the recoil of the expanded parts: the ribs fall back into their places; the elastic tissue of the lung contracts like an india-rubber ball; and the air is expelled. When extra force is wanted, the abdominal muscles contract, and compressing the organs in the abdomen, liver, stomach, &c., force the midrif up, and thus encroaching on the area of the chest cavity, expel the air rapidly.

When any great momentary effort is to be accomplished, the breath is held; that is, the chest is filled and the midrif is fixed until the effort is finished, or until such times as we must of necessity breathe. This, when continued for too long a time, or repeated at too frequent intervals, must work mischief; but these effects will be discussed later on.

In conclusion, then, we see that increase or diminution of muscular exercise involves like changes in the rate of the circulation and respiration.

The various muscles of our bodies that are under the influence of the brain or will are called VOLUNTARY muscles, because we can stop their action, or cause them to act as we please. These muscles are the only form that occur in the limbs and on the trunk; but within the cavity of the body are placed a number of INVOLUNTARY muscles with which the will has little or nothing to do. The heart, for example, and the muscles of the alimentary canal from almost one end to the other, are of this class—acting independently of the brain or will.

The voluntary muscles are also called, on account of their appearance and structure, *striated;* the involuntary *non-striated,* or plain. These terms are not exactly commensurate in their scope, but they are sufficiently synonymous for our purpose to admit of the use of either name.

The voluntary muscles are under the direction and regulation of the CEREBRO-SPINAL system. This consists of the *brain,* resident in the cranium or brain-case, and the prolongation from it that goes down the spine under the name of "pith" or *spinal cord.* From the brain and spinal cord NERVES pass to the muscles, carrying the impulse to move to the muscles; they are called *motor* nerves.

A nerve on reaching a muscle breaks up into fine filaments, and supplies every part of the muscle. It is by the medium of the nerves that the will acts on the muscles; the impulse generated in the brain, flies down the spinal cord and along the nerve to a muscle. The nerves are like telegraph-wires laid on between station and station; the originating battery, the brain, sends an impulse along the wires, the nerves, to work a machine at the other end, the muscle. But just as it is possible to send opposite electric currents along one wire, so in a nerve we have opposite currents. The one we have just spoken of is a downward current, from the brain to the muscles; but there is also an upward current carrying messages from the skin and muscles to the brain; these nerves are called *sensory* nerves, or nerves of sensation, because they carry the impressions of our sensation to the brain, where the knowledge gained from them is converted into motion, or stored up as memory, &c., for future use. The two sets of impulse are conveyed along separate fibres that are firmly bound together; but close to the spinal cord the fibres separate, and we see a motor and sensory bundle.

The involuntary muscles of the body are under the regulation of a separate system of nerves, which, as it presides over the organs of the more animal or vegetative part of our existence, is called the *vegetative* system. This consists of a double chain of small nervous masses called *ganglia,* united together by nerves. The chains are arranged on either side of the spine. From the ganglia, nerves pass to the heart, lungs, and the organs of the alimentary canal, liver, pancreas, &c.—in fact, to all the abdominal and thoracic viscera. On account of the ready disturbance of all parts of this system, when any one part is excited, it is called the *sympathetic* system.

Hence we find that we have *two* sets of muscles presided over in the main by *two* sets of nerves: the voluntary muscles by the cerebro-spinal system, and the involuntary by the sympathetic. The chief difference between the two sets is that one, the sympathetic system, acting on the heart, lungs, and digestive system, continues in action from the birth to the death of the individual, knowing neither rest nor stoppage, as we understand rest; whilst the other, the cerebro-spinal system presiding over the voluntary muscles, requires long intervals of quietude provided for by sleep.

We have absolute command, then, of the one set, but not of the other; we can lay our pens down when we like, but we cannot stop our heart's beat; we can push away the tempting fluid, but cannot prevent its absorption or stay its digestion when once swallowed. Indirectly, however, we can increase or decrease the action of the organs presided over by the sympathetic nerve. Exercise causes our hearts to beat more quickly, our breathing to be more rapid, and our digestion to be stimulated. This is brought about by increase in action in the voluntary muscles, causing more nutritive changes in their substance, and necessitating the hastening of the circulation and respiration to allow of the continuance of the action of the muscles.

PROPERTIES BELONGING TO MUSCLE.

I. The knowledge we have of the exact position of a limb, or the strength we are putting forth, is attained by what is termed the *muscular sense.* When we wish to ascertain the weight of any body placed on our hand, we move it up and down, as the varying contractions of the muscles more readily determine its weight. The weight, as judged by the strength put forth, is determined by the muscular sense. This constitutes a new or sixth sense in addition to the five usually enumerated: seeing, hearing, tasting, smelling, and touching.

II. The action of a muscle generates *heat*, partly from the increased chemical change, and partly from the friction between the various muscular elements consequent on their change in shape.

III. *Electricity* is generated to a considerable degree when muscles are in action.

IV. *Sound* is produced in a contracting muscle. To prove this, put a finger, say the little finger, into each ear, and then bend the finger, or compress the jaws tightly, and a peculiar wavy hum is heard. This sound is believed to proceed from the muscles in action.

V. *Muscular Tone.*—Muscles are at all times, in ordinary health, in a state of what is called tonic contraction, and possess a certain state of tension and contraction, even when the will is not directed to them. This factor constitutes a chief difference between the condition of a dead and living muscle, or a dead and living limb.

THE INFLUENCE OF A NORMAL AMOUNT OF EXERCISE ON A MUSCLE.

Considering all the important changes effected by muscles in action, it is plain that they must play an important part in the economy of the system, and on account of the plurality of the changes, they must at all times constitute an enormous factor in maintaining the balance of health. Not only does the action of muscle have this effect, but the exercise of a muscle is necessary for its *own* maintenance. Each muscle takes its share in the production of heat, electricity, and chemical change, and the accumulated effects constitute the chief manifestations of bodily activity; but these changes are in addition necessary for the continued well-being of the muscle. Supposing an individual muscle is *not sufficiently* used so as to maintain its healthy condition. What happens? It wastes, and by and by degenerates, until no muscular trace can be found in it. This takes place in the following manner. We know from every-day experience that those who take too little exercise get fat. Were we to see an individual muscle around which fat is accumulating, we should find that fat gets to be deposited *around* the muscle, and by and by establishes itself *in* the muscle itself. The white connective tissue between the muscular planes becomes infiltrated with fat, and the bulk of the muscle is increased (see A, Fig. 5). The fat thus accumulated comes to be packed closely, and it is with difficulty that the blood-vessels, going from the surface to the centre of the muscle, find their way in. By and by the difficulty becomes too great to overcome, and the consequence of the obstruction is that the muscular fibres are not sufficiently nourished. As a natural result the fibres degenerate, fatty granules appear *in* the muscular fibres and elements, and they themselves come to be actually represented by globules of fat. (See B, Fig. 5.)

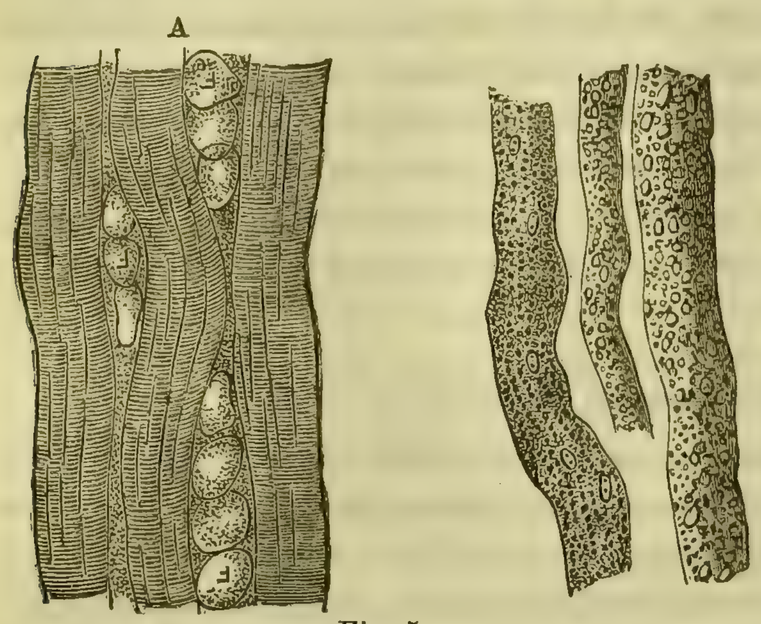

Fig. 5.

A. Fat Cells accumulating in the Tissue between the Muscular Fibres. B. The Muscular Fibres themselves converted into Fat.

Thus it happens that the muscle, from being first infiltrated with fat, comes to be starved out, degenerates, and becomes useless as a contractile tissue. When a muscle has become only infiltrated by fat, it may be restored to a normal state by exercise; when, on the other hand, it has undergone degeneration, nothing can bring back the contractile power. The muscle is said to be "atrophied," or wasted.

As an opposite condition to this, suppose a muscle to be subjected to exercise *over* and above a normal amount. What then happens? The muscle comes to be larger, harder, and stronger. Every one recognises the effect of, say, rowing, handling a spade, &c., on the muscles of the upper limb, and the hardness that the muscles of the leg attain from a good deal of walking. A muscle from any one of these groups would show that there is little or no fat in the muscular planes. The muscle looks red, feels tough, and contracts more strongly. It is said to be, when large, "hypertrophied." Such an effect is produced by training or over-training; but it is difficult to say when a muscle is in a healthy state from exercise, or when it is over-exercised. A muscle brought once to a high state of development and perfection by training, will relapse, when the training is stopped, to its previous condition, or, what is more likely, to a degenerate condition. The process by which it relapses is diminution in size, and it may be in number, of its individual elements. It is found, then, that a muscle to be of use in motion, and to be maintained in its proper form, must be exercised in moderation; and if it is to be used for supreme exertion, it must be exercised and educated up to a state fit to undertake such exertion.

THE EFFECTS OF TOO LITTLE EXERCISE.

I. On the "individual muscles" the effect is, as we have seen, that the muscle wastes, fat gets deposited in its substance, and its elements disappear; the power of the muscle gets weakened, and any sudden strain thrown on it may tear it. This is nowhere better seen than in the case of the heart. This muscle, like other muscles, may become coated with fat, weakened in its action, and when any sudden extra exertion is required, the weakened substance may rupture, and fatal consequences ensue. Other muscles also may rupture when subjected to some action that it is not customary to perform. It frequently happens, also, that a man, say of the age of fifty, on throwing a stone, finds his arm drop helpless by his side, and he comes to realise the fact that there is something wrong. When the arm is examined by a surgeon, it is often found that what has happened is, that a muscle has been torn through, and the swelling in the middle of the arm shows it to be the biceps. Perhaps the individual in question had not used the biceps for a similar purpose for twenty years previously, and the sudden strain on a non-used part of the muscle caused it to give way.

II. When from some cause the activity of a "group" of muscles is lessened, the whole group may waste and degenerate, and if the diminished activity—or, it may be, the complete inactivity—last long enough, the power of contraction may never again be possible in that group. A child with a diseased joint—say the knee—does not use the muscles to move it, on account of the pain induced; and the consequence is, if the disease affecting the joint be of long standing, the possibility of moving the joint, after all disease has disappeared, may be for ever gone. This is a fact of every-day experience, and instances readily occur to every one.

III. A "whole limb," which is, or has been, kept at rest, may be so affected, as in the case of the upper extremity by the protracted use of a sling, or in the case of the lower extremity by too long confinement to bed or in splints.

Should the limb continue to be kept at rest, the same condition is induced in the muscles throughout its length as in the case of an individual muscle or a group of muscles; and the power of the whole limb may be permanently impaired, or all possibility of motion may disappear, a withered limb being the result.

IV. One "half of the body" may be affected with muscular wasting in long-standing or permanent paralysis, and the possibility of all muscular contraction may disappear, never more to be restored.

V. In the case of any individual who habitually neglects the taking of exercise, the consequences will in time tell on his "body generally." We must here consider how this comes about. We have seen that, when a muscle acts, more blood is sent to it, and likewise more impure blood is given out from it. To cause an increase or acceleration in the circulation, the heart must beat faster and more powerfully; and on account of the increased quantity of impure blood manufactured, the breathing becomes hastened in the endeavour to get sufficient air to allow for the onward current of the blood as it passes through the lungs. It is a matter of every-day experience that when one runs fast, one gets out of breath, and the impulse of the heart can be felt thumping away against the side. A quickening of the heart's action and of the breathing takes place also, to an inappreciable extent it may be, when any bodily exercise is taken. When, however, exercise is neglected, the heart has too little to do, becomes thinner in its walls, and cannot adapt itself to any increased strain that may be thrown on it.

The lungs not being sufficiently expanded, owing to the accustomed shallow breathing, any extra work thrown upon them may result in permanent evil effects, such as dilatation of the air-vesicles in the lungs—"broken-wind," as it is usually called in horses, and "asthma," as it is popularly but wrongly termed, in men. Owing to the fact of the circulation and respiration being kept below par by the want of muscular exercise, the whole body will in time show the effects of want of nutrition.

If it be a growing lad, the chest does not expand properly: the bones may grow in length, but not in thickness, and bow-legs or knock-knees may result. If it be a girl who has been denied the proper amount of exercise, she may show it by developing a lateral curvature of the spine—what is known popularly as "a growing out of one shoulder." Combined with these apparent deformities, there is to be noticed in all such persons a pale and wan appearance, bad digestion, bad complexion, head-ache, foul breath, and continued ill-health, which allows but imperfect nourishment to the organs; and the individual grows up a weakly man or woman, fit only to undertake the less laborious duties of life. In the case of adults, the want of exercise first upsets digestion, and then all the concomitant train of symptoms follows. The deposit of fat in internal organs, in consequence of diminished exercise, hampers them in their action, and still farther adds to the impossibility of their doing their work. The heart and blood-vessels especially become weakened, and unfit for any exertion except the most moderate.

Should any extra strain be suddenly thrown upon the enfeebled and wasted heart wall, it may give way at the moment of sudden exertion, and instantaneous death result; or should irregular exertion be indulged in, such as rowing at intervals of months, the heart may become dilated, from the want of power in its walls to resist the increased blood pressure consequent on exertion; for a heart which has, as a rule, insufficient work to do, becomes unfit to accommodate itself to calls for increased exertion, and in consequence dangerous or fatal effects may result from an extra effort. Any attempt at suddenly employing great force may result in rupture of some of the valves or muscular fibres of the heart, or some vessel gives way, and death results. We all know the effects of long sitting, for example, on a clerk at his desk, month after month: how fat he gets. The fat accumulates in the tissues beneath the skin, around the muscles of the leg, and in internal organs; the skin may become puffy from a collection of dropsical fluid beneath, and one can leave the marks of one's fingers on the skin over the inner surface of the shin-bone. The aspect is mottled and clayey; and the increase in weight brings with it a bloodless (anæmic) state of things, from imperfect circulation, and from the unhealthy condition to which the blood is reduced from imperfect oxidation.

We also are familiar with the newspaper accounts of some middle-aged or elderly gentleman running to catch his train, and falling down insensible or dead. In this case, a weakened blood-vessel in the brain has given way under the sudden exertion, and blood escaping on the brain (apoplexy), causes his death.

These are only some of the more decided consequences of allowing tissues to waste and degenerate for want of exercise. But how many such instances do we not see daily amongst all classes? Children, unless prevented by actual disease, need but little encouragement to exercise, as the animal instinct, being predominant, urges them to exertion. Adults, however, from the mode of living necessitated by society, are seldom in a position to get sufficient exercise. The farm-labourer class is the only large class of the community who follows the employment originally meant for us. In every country village, where health is supposed to be found, has not the baker as close an atmosphere to work in as in a large town? is not the grocer tied up to the shop from morning till night? is not the clergyman much more fond of driving than of walking? And so all classes in a country parish, from the highest to the lowest, except those engaged in farm work, have departed from their original calling, and unless care be taken, will become effete workmen, or the generation coming after them will be but ill-developed and puny. If this be the case in country villages, how much more so is it in towns? The grocer in a village has fresh air entering by the shop-door; but the city shopkeeper has, combined with the impossibility to stir away from his counter, impure air to work and live in. Those who can afford so to do live in the country, and come into town to do their work; but how do they come? by train, or by carriage or omnibus, and the good that might accrue from living where they do is largely undone by not using their lower extremities to carry them. All this is necessary from the habits of modern society; but even allowing that, much might be done, and much is really done, to counteract the baneful effects of daily employment, when that is not true exercise. The man who pays attention to such points will thereby engender good health, and his offspring will show by their healthy bodies the effect of well-regulated exercise in the parent.

VI. The effect of too little exercise, occasioned as it is by the compulsory sedentary occupations of modern society, tells detrimentally not only on the individual, but on the "progeny" of such individuals, thereby affecting whole families, "nations," and "races." As an example of an industrious class, compelled by the nature of the work to indoor labour, no better could be cited than the Spitalfields weavers. Here is a class of people who work from morning till night, who have been engaged for many decades at the same employment, whose exercise consists in working and watching the spindle and the loom, who seldom stir out of doors, and who, from the cradle to the grave, scarcely know what a holiday means. They afford the best example known in this country of the continued effects of indoor labour. What do we then find? A small, puny, ill-developed set of people, who, from their birth almost, look old, whose miserably white and withered aspect indicates want of sun-light, and whose look betokens more of sorrow than of joy. Were it not that they are abstemious, they would, as a class, have died out long ere now; but as they are, they are more machines than active livers, and from such a class an individual healthy in mind and body could hardly be imagined to spring. As an opposite example of a class of people who know no labour, whose forefathers for decades have done no work, take the royal families in Europe at the present time. How is it with them? The individuals in these families are, each one almost, endowed with big frames and good health. Than our own royal family, no family of its size in this country can show a better list of healthy sons and daughters, or a family in which physique is generally better marked. Turn again to the German, Austrian, Italian, or Russian royal families, and it will be found that they hold their own in physique with the stoutest peasants in their land. Here, then, is a seeming paradox: namely, two classes of people doing exactly the opposite in regard to their mode of living; one follows that of incessant labour, the other that of compulsory parades and so-called enjoyments and pleasures; one follows the law of labour apportioned to man, the other handles neither the spade nor the plough. In what way is this to be reconciled with the idea that prevails throughout this article? Look into it carefully, and what do we find?—on the one hand, a class condemned to depart from out-of-door employment to handle the spindle: condemned almost to live in cities to be near a market for their goods: condemned to labour all the hours of sunlight, and to be thus denied out-of-door exercise; and thus honest labour is in their case, from the necessity of every-day modern life, productive of physical ruin. On the other hand, we find a class of people who know no manual labour, but who prevent evil arising from the artificial lives they lead by out-of-door sports and pastimes, who undergo muscular exercise in riding, shooting, gymnastics, &c. Which of these two classes, then, have the better physique we have already stated; and it upholds what is the only possible ground to argue from in the state of society as it now exists, namely, that close employment without out-of-door exercise is ruinous to the individual and his progeny; but that employment, combined with artificial exercise, which is the state most of us can attain, or even artificial exercise without definite employment in business, as is the case with the upper classes and especially royalty, produces a race in which artificial exercise has compensated for the want of the employment of muscular activity in earning their daily bread. Not only so, but artificial exercise is capable of producing individuals fit to perform greater muscular feats than were ever recorded. Hence there is no necessity to lament our position, as it is possible for almost every one to follow closely the city life of to-day, and still by a system of exercise to compensate for what might be imagined to be, at first sight, an irretrievable annulling of Nature's laws. These may be considered extreme instances by many readers, but take familiar instances we see around us. Examine the history of any of the leading men in almost any branch of industry in one of our large towns. Consider the parentage of such, and where they came from. How many of these men were born in the town in which they attained eminence? or perhaps it would be better to consider where their parents were born, and how they lived. The boy who becomes a Lord Mayor is always pictured as coming "into" London from the country; and without drawing upon the imagination, let us consider the parentage of the Lord Mayors for the last thirty years. Of the number occupying the mayoralty during this time, twenty-five were either the children of parents who were importations to London, or themselves came into London at an early age. It is better to take these as examples, in preference to judges and politicians, &c., who, if born in towns, must almost of necessity have spent their youth at one of our universities or public schools, where, during the period of their youth, say up to seventeen or twenty, they have built up, under well-regulated mental and bodily exercise, a stronger frame, and started life with a better-formed physique than the son of a townsman, who, trained in a city school, enters an office at fourteen, and pursues his calling forthwith. We find that the chances of such a lad attaining eminence are not great, and that of such stuff our greatest citizens are not made. Pursue the history of this town boy still farther, and it will be found that the sedentary life inculcated, the close application, the hurried meals, the continual mental strain he undergoes whilst he is growing to manhood, are, in the face of them, but little calculated to engender the belief, even to a casual observer, that his children would be endowed with strong frames, or capable of much physical endurance. It is difficult—I will not say impossible—to find a third generation of pure Londoners, because the father or mother, a grandfather or grandmother, is almost certain to prove to have been an importation into London, and the evidence forthwith breaks down. But it is doubtful if more than three generations are possible. We know that in India the third generation of Europeans do not reach maturity, and there is but scant proof of pure Londoners continuing to four or five generations. The term pure Londoner is difficult to explain and limit. However, there are in London two millions of people whose parents have lived in London, whose sole knowledge of country air and scenes is gained, it may be, by an occasional Bank Holiday excursion. These are to be considered pure townsfolk; and it is in this class that the effects of town life on the progeny show in the extreme. In this class it will be found that the third and fourth generations are puny, and that the children of these late generations seldom reach maturity. Not only is it physically that a family or nation declines, but with the stunted frame is a brain that begets morbid thoughts, that engenders a weak mind, that allows the individual to be driven to rash deeds—a mind that knows no control, the owner of which becomes the slave of his morbid inclinations.

How good for our national welfare would it be did the future "bodily" state of those who are to succeed us enter more into our calculations in every-day life. Did the fact of bestowing healthy bodies to succeeding generations concern us equally with the more selfish interest of our own spiritual welfare and future state, were the term "nature's law" considered as synonymous with "God's law," there would be a fewer number of "weak" people amongst us, and, as a consequence, more healthy doctrines, less crime, and a more true Christianity. It is the unsound body that possesses an unhealthy brain: unhealthy, as judged by the morbid ideas it begets, and the crime that it forges. As a healthy heart giveth forth normal sounds, so a healthy brain begetteth wise thoughts.

Every one of us knows of families falling into decay, and we are familiar in history, both sacred and secular, with race driving out race, and nation succeeding nation. The cause of the decay of such and such a person or family may be apparent to those in the neighbourhood in which the family lives. A man who acts unwisely is often described as a "poor thing," or a "poor weak creature." This may refer to merely physical qualities, but more often to both physical and mental inaptitude; and just as this "poor thing" drifts into unwise extremes, whether in religion or revelry, lavishness or niggardliness, æstheticism or effeminacy, so may a nation fall into decay and ruin, and become the prey of the progeny of a more sturdy race. A thought concerning the great peoples of the world affords ample proof of this fact, and near our own time we have the decline of Spain and the Spaniards, than which no better example was ever afforded. Their greatness was but of yesterday, and their rise and fall is shortly told. Overrun by the Moors, Spain was held in their hands for many centuries, and the Spaniard was condemned to labour and toil. By and by, from out of the stout peasant race sprang men with strong wills and indomitable courage, and the Moor had now, in turn, to succumb to the despised hirelings. This hardy race not only freed their country, but went forth to all the ends of the earth, spreading civilisation and adding to their wealth. In time the accumulated wealth told its tale; unable to resist the temptations of ease, the children of the active spirits grew up to laugh at labour, exertion was considered to be vulgar, and in a few generations the nation became effete. Every one of us knows of a family or families sent to destruction by the sudden accession of wealth. The day's work, thereby entailing exercise and mental occupation, is exchanged for carriage-driving and late hours, over-eating and over-drinking, and Nature is denied a voice in the luxurious and gluttonous household. The progeny of such cannot be healthy, and weak children are begotten who, if not swept off by disease, drift into crime or become useless members of society. How many families of self-made men, as they are called, do we not see die out? The children of such are frequently trained in luxury, and succumb to its evils; and the generations as they go on become more and more effete, until at last Nature denies a continuance, and the family is heard of no more. As in families and nations, so with races: they disappear to be heard of only in out-of-the-way corners of the earth, and their influence in the world, which was once paramount, becomes trivial and worthless, and the business of the world is done by the more hardy races. Take for example, the Saxon and Celt, the New Zealander and Maori race, the American and the Red Indian. These afford examples before our very eyes of peoples who are, and have been, disappearing; and from analogy we may assume that the fact of such a race as the Red Indian or the native Australian ever having lived, will be gathered in time to come only from historical records and museum collections. The last of the native Tasmanian race died some few years ago, and information about this section of human beings is to be obtained only from the annals of the historian.

From all this, then, let us learn that when a family, sect, nation, or race departs from a natural to an artificial mode of living, that family, sect, nation, or race will become obsolete, unless means are taken to provide for its physical development; and that this is best obtained by providing attractive and healthy pastimes, which can be indulged in concurrently with average every-day work.

OVER-EXERTION.

The consideration of this subject will be best discussed by reviewing the probability and the effects of its occurrence at different periods of life. Amongst CHILDREN, when left to their own free will, there is scarcely a fear of the possibility of over-exertion. Before the muscles can be overworked—that is, worked in spite of fatigue—the will must be brought into play, and a spirit of emulation developed. The child's mind scarcely understands emulation, and its will is not brought into play to urge the muscles on to prolonged exertion. The child collapses, when tired, into rest and sleep, and so saves itself from over-exertion. Children who are trained in gymnastics for purposes of public exhibition are happily a minimum; but even with them, their trainers understand from experience that it is unprofitable to urge them to over-exertion. We often hear it said that a child has been put down to walk too early, and we see bow-legs, knock-knees, and other bodily deformities arising accordingly. These troubles may not be, but very frequently are, associated with rickets—the *maladie anglaise,* as foreigners call it, on account of its enormous frequency in England. In this damp climate of ours, with its feeble sunshine and murky atmosphere, where, in addition, thousands upon thousands of manufacturing chimneys pour their smoke and foul gases into the air we breathe, how can it be otherwise than that the ill-cared-for child should succumb? The child, from want of light and fresh air, and the frequent impossibility of going out-of-doors owing to the weather, gets out of health and condition; the bones are not properly developed, and their mal-nutrition becomes apparent by their not becoming hard enough to support the tension and traction of the muscles, and the weight of the body. These changes, then, are not dependent on over-exertion, but on the soft condition of the bones, which renders them unable to resist the least muscular force. In the treatment of these cases motion has to be stopped for a time, as the bones will become more and more misshapen should the muscles be much used. With these remarks we may then dismiss the evil effects of over-exertion in children.

It is, however, totally different when the period of YOUTH is reached. The spirit of emulation comes into play, and the will is brought to bear to urge the exhausted muscles to extreme work. A lad is urged on by emulation to win a race, to throw his opponent in a football scramble, to lift a heavier weight than he ought, and so to bring disease upon himself. A girl is induced by the gain likely to accrue from, or the liking she has for, piano-playing, painting, sketching, fancy needlework, &c., or she may be driven to some of these by dire necessity, and may, by over-exerting herself, cause deformities or bring on ill-health. She gets tired, by and by becomes exhausted, but the work must be finished, and so she sets to work again, day after day and month after month, until changes occur in the shape of her spine, or ill-health compels her to give up work.

In the case of sudden muscular exertion, as met with in field sports, the chief direct danger is to the circulatory system. When one braces one's self up to undertake any greater exertion than ordinary, one does so by taking a deep breath, fixing the diaphragm (the midrif), the muscles of the chest, and the muscles in the larynx (wind-pipe), so as to render the chest a rigid air-box. Should it be a jump that is to be performed, a short hundred yards' race that is to be run, or any extreme exertion that occupies but a short time, one scarcely breathes at all during the performance of the act, and a severe strain on the circulatory system is the result.

Even when one goes up-stairs quickly, or comes to a slight rise on the road, involuntarily are the midrif and chest fixed, the breathing is impeded, and when one reaches the top of the ascent one is out of breath, and the heart is quickly palpitating. So with rowing: by many people the breath is held during each stroke, especially when a spurt is put on, and, as a consequence, rapid breathlessness and exhaustion come on. In the same way, during singing, public speaking, and preaching, breathlessness and fatigue will ensue in those who, inexperienced in such attempts, start off with buckling themselves up to make themselves heard by fixing the midrif and the chest generally. In another way do we find, as an every-day experience, the effect of not breathing. When the mind is attentively fixed on any single subject—such as the developing plot of an exciting novel, or the hair-breadth escape of a stage hero, the breathing is very shallow, and sufficient air is not entering to satisfy the blood in the lungs. When the exciting period is over, when the volume is finished or the curtain dropped, Nature re-establishes herself, and the deficiency entailed is made up for by a deep sigh and then by frequent yawnings. Who has not been annoyed, whilst at a concert or theatre, to find one's self yawning again and again, or to find one's friends doing the same thing? The fact is that during the performance one's attention is so fixed that the breathing may be stopped for a while, or continued in a very imperfect way, and deep draughts of air in the form of a yawn have to be taken, so as to obtain sufficient to satisfy the blood. However anomalous it may seem, deep yawning at a concert or play frequently betokens intense enjoyment rather than weariness.

It is the effects, however, of sudden or great exertion, as it affects the circulatory system, that we have to think of here. In consequence of the breath being held during a severe muscular strain, the blood is stayed in its passage through the lungs; not meeting with pure air, it refuses to go on, and the veins and venous system get congested, and the veins stand out prominently. The blood cannot pass from the right to the left side of the heart, as it has to go through the lungs on the way, and, as a consequence, the right, or venous, side of the heart becomes choke full. The walls of the right side of the heart will, on frequent recurrence of this condition, be unable to resist the pressure of the blood, and the cavities of the right ventricle and right auricle become dilated. This, once induced, is a permanent condition, and gives rise to many troubles, such as chronic bronchitis, dropsical swelling of the legs, palpitation, feeling of suffocation on exertion, and arrest in growth and general puny condition if the youth is not already fully developed.

Holding the breath during prolonged or frequently occurring severe strains may also induce evil results in the lungs themselves. Let the reader here pause for a moment, and try the following experiment. Take a deep breath, fix the chest by preventing the air escaping; now try to force the air out, but still hold the breath, and it will be felt that the midrif is contracting and the abdomen receding. The consequence is that the air in the chest is being compressed, and the walls of the lung in which it is contained must be enduring a great strain. Should this be too great or of too frequent recurrence, as happens in exertion, the elastic tissue of which the lung is largely composed will rupture, and the lungs will become permanently distended. The chest will be permanently over-distended, assuming the barrel shape, as it is called; the shoulders will be raised to accommodate the big lungs in the chest; and an apparent short neck result. This is the condition called "emphysema." A horse suffering from this is said to be "broken-winded," and it is the same condition precisely that is induced in the horse as in ourselves. Asthma is a name also given popularly, but wrongly, to the same condition, asthma being a totally different disease. These and many other evil results may arise from extreme exertion, especially in those youths who are not in training, or who know not how to manage their breathing and strength when they are suddenly called on to perform an extra great muscular task. Let no lad, then, indulge in prolonged trials of strength who is not under the eyes of a trainer, or some one to guide him safely, and point out to him how to avert the dangers that may cause fatal consequences.

Amongst GIRLS, whether they be highly educated and kept at school until they are eighteen, or whether, on the other hand, they be sent to work at an early date, there are many maladies that may be induced by over-exertion. A girl's life after twelve is so totally different from a boy's—the daily life, the pleasures and pastimes of the two are so distinct, that it is to be expected that a different set of troubles will arise from over-exertion. And that this is the case will be seen below.

Girls are ready for work at an earlier age than boys, and have often to submit to severe muscular endurance at a very early age. The simple exertion of standing for hours together is nowhere better exemplified than in the class of shop girls. The number thus employed in this country are hundreds of thousands; and as a smart manner and good appearance are high qualifications for the office, it happens that the physique of an enormous number of healthy girls is destroyed by this seemingly simple labour. In the first place, the fact of being indoors from morning till night is terribly against health; next, the standing at and leaning forwards over a counter is a severe muscular strain, especially on the muscles of the back and the calves of the legs. Let the reader here try the position for, say, five minutes, by simply standing up, keeping the feet together, and leaning forwards over a table; it will be then found that the strain on the muscles of the regions mentioned is immense, and fatigue rapidly ensues. Imagine the exhaustion that must ensue after days and weeks of such a trial, as is the case with the shop girl or barmaid. Let us now trace the consequences of this position. We know, from considerations already entered into, that when a muscle acts, blood is carried to it in increased quantity. To the muscles of the calves of the legs, then, blood must come in great quantity as the effect of long standing; at first the muscle increases in size and strength, but the consequence of the prolongation of the strain on the vessels is that by and by they refuse to obey the calls of the increased pressure, and begin to dilate. The veins, having the weaker walls, dilate first, and soon show themselves prominently beneath the skin as varicose veins. Continued standing may cause the veins to rupture and bleed, or set up a foul ulcer of the leg, difficult to heal, and rendering the girl unfit to continue her occupation, or to take walking exercise.

No more common disease is known amongst girls concerned in such employments, and there is no disease that makes life more miserable. Although I have cited one class only as an example, a similarly afflicted and still more numerous class, as being found in every corner of the kingdom, are washer-women. Their position whilst at work is even more trying than that of the shop-assistant at a counter. The bending over a tub necessitates a still more severe strain on the muscles of the lower extremities, owing to the still more stooping position of the worker. Varicose veins and hideous ulcers predominate amongst this class to an extraordinary extent.

The internal complaints induced in girls from unhealthy or over-tiring employment cannot be discussed here; but it would be a dereliction in duty not to turn for a short period to try to explain changes in the spine, which go by the name of "growing out of the shoulder," or "lateral curvature." This deformity, although not necessarily associated with disease, is so productive of misery and annoyance to the individual, and such an anxious consideration to parents, that to understand it, the reader must consent to go through the following details. The back-bone, or spine, consists of a column of small bones (called vertebræ), piled one on the top of the other. Between every pair of bones, pieces of soft tissue are put in, to allow of the bending or twisting of the column in every direction; so that whilst this column is firm it is also freely flexible. Ribs are attached to the back-bone in the chest region, and the upper extremities rest on the upper ribs. Naturally the spine is curved in an antero-posterior plane, but it is when a decidedly lateral or side to side curvature appears that the deformity spoken of arises. Even this lateral curve exists to a *slight* degree in almost every person, owing to the use of one hand more than the other. The continued use of the right hand, for instance, tires the shoulder, and the head falls towards the right, whilst the spine is bulged towards the left shoulder. When this is excessive, the left shoulder becomes prominent, and is often the first indication that something is wrong. On examination by a surgeon, it will be easily demonstrated that it is not the shoulder that is affected, but that the bulging of the spine towards that shoulder is the cause of the deformity. Mild degrees of this inequality of the shoulders is an every-day experience; a schoolboy, accustomed to carry a bundle of books below the same arm to and from school, will naturally incline towards the weighted side; an army officer, from carrying his sword on his left side, comes to drop the corresponding shoulder; a man or woman accustomed to riding shows an inequality of the shoulders from the extra work given to the rein-holding hand. These and many other familiar instances might be readily cited, in which the trouble is hardly perceptible. On the other hand, the deformity may become marked, and require consideration. The age at which it is most likely to appear is at or about puberty. Both sexes are liable to it; but it is more common, because perhaps more easily noticed, in young women than in young men. At or about puberty is the period of rapid growth and development. The bones lengthen rapidly, and as they are still soft and cartilaginous in places, the muscles on opposite sides of the body require to be kept in an equal state of tension; otherwise any continued action of one group of muscles, say the upper extremity, to the neglect of the corresponding group of the opposite side, will cause the soft bones to be bent. Should development rapidly follow, the bones may become hard in this position, and a permanent lateral curvature be established.

Almost all employments necessitate the use of one hand more than the other; but we have only to discuss the work that is set girls to do at the age mentioned. If the girl belongs to the upper or middle classes, she is almost invariably away from home at school at this period. She has to practise at the piano long hours together, to write, to draw or paint, to sew, knit, tat, crochet, &c. The arm aches after a time, and the fatigued limb causes an involuntary drop of the shoulder. The girl requires all her strength at this period to support her in her rapid growth; and this extra and unbalanced use of one part causes an impression on the soft bones with which the muscles that are called into action are connected. If the girl belongs to the lower classes, sewing or machine work, flower-making, &c., may be her daily employment, giving rise to like troubles.

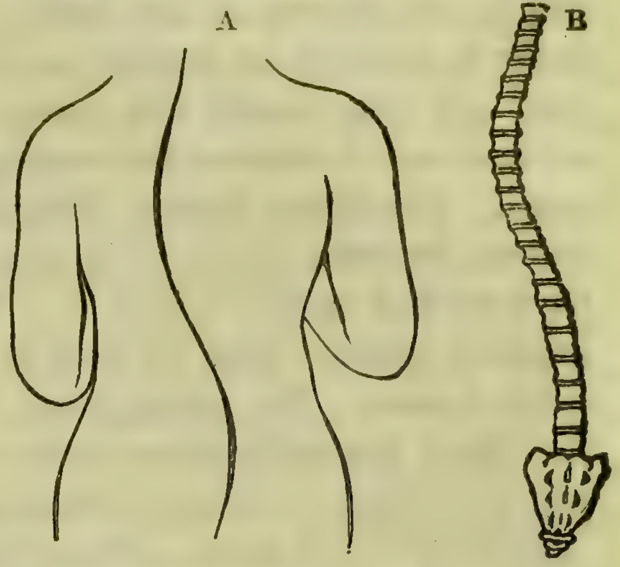

Fig. 6.
A. Figure showing Curvature of the Spine; B. The effect of such a Curvature on the Vertebræ.

What mischief is wrought in boarding-schools with the health of young girls! All sorts of strains, both mental and physical, are put on them. The continual sitting bolt upright in a chair; the continual calls to attention, to position, and appearance; the close confinement indoors; the habit of sending country girls to towns at the most critical period of their lives, are all conducive to try the health and strength of any girl, however robust. The exercise afforded to boys is plentiful and varied, but what have girls in the way of out-of-door games? Except lawn tennis, practically none. For no account can be taken of the daily two-and-two boarding-school walk: an infliction that has to be gone through, in which the girls may neither look to the right nor to the left, may neither smile nor run—may do nothing, in fact, that nature prompts them to do.

Place a handcuff between the two as they walk out, and you do what is being done to these young girls' spirits. What is the consequence after school days are over? As the captive revels when set free, the girl rapidly falls away from her stiff training; she has two lives, one, the boarding-school life, for her society manners, another, the opposite, for home life in which she is sure to run to the opposite extreme. She may be chosen for a wife by some one who sees only the boarding-school side of her existence. After marriage, the revulsion from this, the training of her youth, becomes more marked, and the accomplishments and training are laid aside, she becomes careless alike of her own improvement, her husband's feelings, and her children's mental welfare. Depend upon it, this is one of the chief causes of unhappy homes.

Over-exertion to people in *advancing years* is attended with many dangers. The dangers are brought about chiefly by the changes which are being wrought out in the tissues of the body. No tissue or organ of the body shows signs of decay to so great an extent as the circulatory system. The blood-vessels become less and less elastic and more and more brittle as years advance, until, when extreme age is reached, the vessels are as hard and as brittle as a piece of mother-of-pearl. The heart, finding difficulty in propelling the blood through the narrowed vessels, becomes increased in size and thickness from extra work, just as any other hard-worked muscle would do. The brittle-walled vessel may give way from extra pressure thrown upon it, such as running, as one sees stupid old people doing, to catch a train. The strong heart is set beating more quickly from the exertion, and the blood thumping away against a weak-walled vessel will cause the walls to give way and blood to escape. Should this be a blood-vessel in the brain, as it often is, "apoplexy" will ensue, with all its train of troubles.

Another result of age upon the heart is fatty degeneration, already spoken of when discussing atrophy of muscle. As one passes from infancy to old age, the fat which was accumulated beneath the skin departs from there, and comes to be deposited on internal organs. The heart, with other organs, gets coated with fat, giving rise to what is called a "fat heart." By and by, from the interference of this with the nutrition of the muscular fibres, the walls of the heart become weaker and weaker, owing to the fatty degeneration, or the subsidence into fat, of the muscular fibres themselves. Any person with his heart in this state is subject to fainting-fits, and attacks of flushings of the face; fat grows apace, and flutterings of the heart cause great annoyance. It is easily seen, then, that as a person advances in years exercise must be modified to suit the brittle vessel or the fatty heart. Sudden bursts of violent muscular movements cannot be withstood; and the strong man who, but a few years previously, could lay aside his pen to scour the hills with his gun, will, when he gets a few years older, have to suit his out-of-door pleasures to the state of his circulatory system. These and many other ills might be enumerated, such as rupture, paralysis, blindness, &c., that ensue from any sudden strain attempted by an old person. Walking is almost the only exercise suited to those of advancing years, and that must be indulged in with a due consideration of the strength in each individual case.

As years accumulate, so feelings of getting "old" creep in apace; but this period varies with different individuals, not only according as they are in practice or training, but also according to the idiosyncrasy of the individual. No two are exactly alike in features, expression, feeling, or brain power, and just as dissimilar are people as regards physical endurance; and what is sufficient exercise for one, may be to another either too little or too much. There is, then, no general rule to be laid down; each individual must find out by experience what is sufficient, and what is not. In fairly healthy people it is not until after thirty or thereabouts that one begins to observe one's own peculiar physical idiosyncracies, and to act upon them. By and by, on observation, a store of knowledge is laid up, until it is said "a man is either a fool or a physician at forty." From forty onwards, as years advance, one has to leave off the more violent exercises to allow for the altered condition of things; but in all grades of life one sees old people working their ruin by over-exerting themselves. An old City gentleman running to catch his morning train; an old farmer hastening to turn the strayed sheep out of a corn-field; the old sportsman having a last run with the hounds; the last game at cricket; the last pull on the river; it is always the last, because one goes on again and again, having "lasts," until something happens to incapacitate one from doing the same thing again.

We see, then, that over-exertion may occur at all periods of life, from youth upwards; that it is the will that urges on the flagging energy to over-exertion, and thereby brings on physical ruin, or death. The golden rule is "to stop work when one feels tired"—*i.e.*, when the muscular, respiratory, and circulatory systems show signs of fatigue. As years advance, a thinking man struggles to meet his own particular case, until it is only at the close of life one finds out how to live. Each one is his own barometer in regard to what constitutes sufficient, too little, or excessive exercise. It is well that during the period of youth and early manhood an enormous amount of exercise can be easily recovered from, as the heedless use young men make of their strength and spare energy would engender ruin to their bodies, and annihilate the race. It is when years are creeping on, and the tissues are less able to stand sudden onsets of work, that permanent danger is certain to result.

TRAINING.

What is more common than to hear said, when muscular exertion is undertaken, that it is impossible, as "I am not in training," or "I am completely out of condition?" These are phrases which, in the popular sense, every one understands. It means that the muscles of the body are not in a state to allow of the performance of some severe, sudden, or difficult act. Further, it also implies that had the process of training been gone through, the muscular feat could have been tried, and with good hope of success. What, then, is the difference between being in training, and being out of condition? We so fully discussed in an early part of this article the effects of action and inaction on muscles, that it is not necessary to go over the same ground again; suffice it to say that muscles when not used sufficiently, waste, as in a cripple's limb; but when fully employed they grow in size and strength, as, for example, a blacksmith's fore-arm, and a pedestrian's leg. In one state—that of too little exercise—fat accumulates around the muscle and hampers its action, or the muscular fibres may even degenerate into fat. All this was previously explained. In training, however, the opposite condition obtains. The quantity of blood circulating in the muscle is increased, the fat deposited in a period of quietude is absorbed, the bulk and hardness of the muscle is increased, and the muscle is to be felt as hard as a board beneath the skin. The consequence is, the amount of strength resident in the muscle is magnified, as evidenced by the increased power and capacity to execute muscular feats which were previously impossible.

Not only is it the muscular system the condition and power of which is altered, but the circulatory and respiratory organs are also changed in their capabilities to an extraordinary extent. The breathing apparatus is just as capable of being carefully trained as the muscles; and the circulatory system can be made to endure severe strains, which without training might have caused death. When one is out of condition, the breathing becomes quick and hurried during any exertion, until at last one has to stop from breathlessness, and the heart beats so rapidly that it gets off the balance and causes extreme discomfort. By training, however, the breathing is rendered freer, and more manageable; the blood-vessels can be educated to allow for the increased supply of blood rushing through them, without much danger of the wall giving way; and the heart is indirectly regulated to undergo but little or no discomfort from even a four mile race in an outrigger. Hence not only are the muscles improved, but the circulation and respiration are benefited and strengthened. Many mental philosophers say, Why use our muscles at all? Is it of any use improving the muscles of our legs and fore-arms, and wasting strength of which we have only so much to spend? Is not the brain better able for increased work when the chief supply of blood is directed towards it instead of towards our muscles? Interrogate such a one thus: Is it your desire to live to a good age? The question is necessary, as a man with such a perverted notion of things is likely to have sepulchral theories in regard to life, arising from indigestion, headaches, and all the concomitant evils resulting from ill-health. Receiving an answer in the affirmative, point out to him that he cannot do so unless he maintains his circulation, respiration, and digestion in good trim; that there is no way of reaching these to improve their condition other than by muscular movements. The heart is meant to act, and not stand still; its very action is the secret of the continuance of its strength; diminish that action, and its strength fails; maintain it, and its powers endure. Exercise is necessary, again, for digestion. The diagrams given (Figs. 7 and 8, p. 424) show the situation of the liver and stomach in regard to the diaphragm, and the reason of their being there is the compression and motion they receive from the diaphragm and chest wall. Diminish the action of these surroundings, and the digestion will be upset; maintain their full force, and they will promote it. Since we have shown that the circulation, respiration, and digestion can be maintained in their healthy action only by muscular exercise, it is unnecessary to discuss further the question of the use and necessity for such exercise; we adopt it as an undoubted truth.

The process of training that has to be undergone by athletes nowadays is reduced to hard and fast rules. That these rules are not so good or scientific as could be wished is a matter for regret. The work of training is left to "trainers," and they are men who, learning from their predecessors whatever facts were known to them, build up a code of rules framed largely on imperfect experience, and added on to by what they have themselves believed to be useful. Medical men of reliable knowledge and sound professional attainments have seldom lent themselves to consider seriously the subject of training, and so place the subject on a sure scientific footing. Many of the methods used by "trainers" are largely empirial, and they are found to be good or bad only when they succeed or fail. The failure may, however, do much damage to the pupil, and many a man breaks down in training from being made the subject of some imperfect or unsuitable *régime*. This is a cause of failure, no doubt, and an important one too, but equally so is an attempt at training by an individual constitutionally unfitted for any such process. It is the consideration of the health of the individual who is to undergo training that should be of the first importance; only healthy persons should submit to a process of severe training. But what is health? and who can declare that he possesses it? To answer this directly or define health accurately is impossible, no two people attaining the same standard. How common is it to hear people say, "they never had a day's illness in their lives;" and when one comes to inquire into it, one will find that the fact of their having had a fever, a broken bone, a sprained joint, a cold that kept them in the house for days together, is forgotten, and most of us have to puzzle our memories to remember if we ever had any illness. It is a great happiness to think that such miseries are not remembered, and that the memory of the black days in our health calendar is left behind us on the sick-bed; but most of us, were we submitted to a careful physical overhauling, would find ourselves enumerated, were we categorically summed up as horses are, in the class of "screws."

Training brings out our weak points as well as our strong; and if the weak points become pronounced, it is evidently time to stop. Two men apparently in sound health, and submitted to the same form of training, may show wide differences as the result. One may go through the process with apparent benefit to himself; the other may break down, with serious consequences to his physique. So that training may do no damage to a healthy person, but in one who has a weak point in his economy the process will almost invariably find it out, and render active some disease that might have otherwise lain dormant. Should a young man with a tendency to scrofula, consumption, inflammation of the lungs, or rheumatism, indulge in a system of training necessary for a supreme effort, he will be fortunate if he does not break down during the process, or succumb after the event, from whatever bodily malady he may inherit from his parents—a malady which, had it not been probed by ill-adjudged muscular effort, might never have been known of. Are such persons never to have exercise? That is a totally different question—one that can have only one answer. The answer is, let all and sundry indulge in moderate, every-day exercise, as most of us know it; but let no one, however healthy, submit to a course of training until he has been first examined by a medical man. Medical men, however, are but seldom consulted until it is too late; until the evil is wrought, and repentance for not following sound advice is at hand. This is a state of things that ought to be stopped. No young man ought to be allowed by his parents or guardians to proceed to great trials of strength or endurance without being first carefully examined; and not only so, but during the process of training, at frequent intervals, he ought to be submitted to careful examinations. Just as recruits for the army are examined, so should a recruit for training be examined, only much more carefully; for it is a greater effort to engage in training for a four-mile rowing contest, than to fight under an Indian sun. Proportionately more lives are lost yearly from an indiscreet use of strength, than are killed in engagements fought by our countrymen against a foreign foe.

To enter into all the concomitant dangers of severe muscular exercise would be to go into a multitude of details of disease that would fill volumes. However important that might be to medical men, it is irrelevant here; and we shall be content with simply pointing out some of the troubles and diseases that are apparent, and likely to occur. The full list of such will be given hereafter, and the dangers peculiar to some of our national sports are pretty fully dealt with under the heading Sports and Pastimes.

The dangers of training are both immediate and remote. By immediate dangers are meant those which develop during the process of training, or at the time at which the supreme effort is being made; by remote, those which arise after the training process is finished. As examples of "immediate" dangers may be mentioned:—1. A gradual falling off in tone and vigour; 2. The rupture of a muscle; 3. The rupture of a blood-vessel in the lung, brain, or eye; 4. Dilatation of a cavity or cavities of the heart; 5. The giving way of a diseased valve in the heart; 6. Catching cold from being exposed in all sorts of weather in insufficient clothing, the result being bronchitis, pleurisy, inflammation of the lungs (pneumonia), rheumatic fever. 7. A host of abdominal and cardiac troubles, such as abdominal rupture (hernia), twisting of the intestines, giving way of a heart-valve, &c. As examples of *remote* diseases may be mentioned:—1. Arrest of growth and development in young men; 2. The lighting up of dormant diseases, such as struma or scrofula, tubercle or consumption; 3. Kidney disease, resulting from imperfect nutrition and overwork; 4. Permanent injury to joints; 5. Lateral spinal curvature, especially in girls; 6. Varicose veins. This fearful table of possibilities is laid down, not with the idea of checking the pursuit of games and pastimes—far other is the idea; it is rather to encourage their pursuit in safety, by urging the necessity of having all, if that were possible, but having at least all the boys and young men at our public schools and universities submitted to careful medical examination *before* undergoing severe training. Nothing brings a game or sport into greater disrepute than to hear of a death resulting therefrom; and a boy is forbidden by his anxious parents to prosecute this or that game accordingly. When facts come to be analysed, it will often be found that death resulted from some physical defect that was not known to those in charge of the boy. Had a medical examination been instituted *before* the game that proved fatal was indulged in, a life might have been saved, and the pastime would not have obtained a bad name throughout the length and breadth of the land. It is to prevent such catastrophes that the list of casualties above enumerated is given; and by the preventing such, the game is fostered and encouraged. Let not the reader go away with the notion, then, that an attempt is being made to frighten people from indulgence in sports; what is intended, is to frighten those in charge of children into having a thorough medical examination from time to time, especially when their *protégés* are about to engage in any supreme muscular exertion. Should the above statement ever catch the eye of the responsible head of a school, his answer would be: We have a highly proficient medical man in attendance upon our boys, and we do take steps to provide against such calamities. When, however, one comes to look into it, it will too often be found that the medical attendant looks after not the health, but the diseases of the boys. It is only when some illness necessitates medical treatment that the condition of the lad is found out. Evidence is not far to seek to prove that schoolmasters of the highest class, and medical attendants of the highest skill attached to schools, allow boys, with actually pronounced disease of the heart, to run, row, indulge in gymnastics, drill, cut wood, &c. The fact of heart trouble is not known, because the boy has never been under the doctor's care; and it is only when some further mischief is done producing actual illness that an examination is made, and severe measures, it may be all too late, are taken. What should be insisted on by the responsible head of every public and private school is an exact statement by a medical man of the health or condition of the pupil on the occasion of joining; and not content with this, a process of physical examination should be repeated at intervals of at least a year.

Turning now more to the distinctive details of training, of the first importance is some knowledge of the process by which muscular force is supplied, and of the means whereby it is maintained. To enter into an account of the organs involved would necessitate a complete description of the anatomy of the body, as every organ is concerned in the production of energy, some more some less. We shall, however, trace the process in as simple a method as possible. The object of this is to see whether we can reduce the scattered facts that are known into a comprehensive whole, and induce some sound principles to go on, in this, the maintenance of health. As an instance of the state of things at the present moment, we have only to analyse the expressions of opinion one daily hears: one food is considered to be "good for one;" another is "strengthening;" a third is "muscle-making;" a fourth is said "to stick to your ribs" and so prolong endurance. Other foods are avoided as being "weakening" and deleterious.

One has only to listen to the tattle around the ring of a walking competition to become acquainted with the various beliefs of the different competitors. You will hear how one eats jelly; another chews some wonderful nut or leaf; a third drinks water or cold tea; a fourth eats meat and drinks beer; a fifth relies for strength on eggs and spirits, and so on. In any test of endurance, the widest divergence of opinion is believed in and acted upon. It is, then, to clear up these wild statements and divergent beliefs that we propose to discuss the subject here. The means whereby we obtain strength and maintain it, is by the food we eat and the air we breathe. Food is introduced by the mouth, swallowed, digested, and absorbed. Alone, food is useless, as oxygen is wanted to act on it, and this is provided by the act of breathing. Oxygen oxidises the food, thereby producing force capable of being expended in any of the many ways we know of. These are chiefly:—1. The production of heat; 2. The forces expended on the processes of digestion, circulation, and respiration; 3. The performance of muscular acts. We might compare our food-taking, respiration, and circulation to the warming a house by a boiler and pipes. Water is put in the boiler, and coals in the furnace beneath. The coals are represented by the solid food we eat, and the water in the boiler by the fluids we drink; both, however, enter together in our economy by the mouth. The water and coals, however, are no good without heat, and this is supplied by the presence of the oxygen in the air sweeping through the furnace. So our food would be useless to us were it not for the oxygen of the air that enters by respiration. The consequence is, the warm water in the boiler is driven through the pipes, just as the warm blood is circulated in our body. The result of supplying fuel to a steam-engine is the expenditure of force and motion; the result of supplying food to our bodies is the same. But the burning of fuel means ashes, so the consumption of food necessitates excretion. The consideration of the action of the steam-engine shows us that fuel and oxygen are supplied (ingesta), force is expended, and ashes or refuse (egesta) result. The consideration of our economy shows us that food and oxygen are supplied (ingesta), force is expended, and various organs are concerned in excretion (egesta).

To maintain health it is necessary to have the three balance properly: the food taken should neither be too much nor too little; the force expended should be in proportion to the food absorbed; the excretions must be maintained and regulated, otherwise ill-health will follow. The food we eat we can regulate in regard to quantity and quality, and, as we shall see, certain foods provide more energy than others; the force expended we can limit by stopping when fatigue comes on, or when experience tells us we should; the excretions, also, we have command over by attending to the four primary excretory organs—the bowel, the kidneys, the skin, and the lungs. The first two are affected by what we eat and drink, and by various drugs that increase or diminish their action; the skin is under our own control whilst soap and water and change of clothing are at our command; and the lungs are largely affected in their excretion by the ventilation we maintain in our rooms, and the amount of out-of-door exercise we take.

Food.

Here we propose to discuss food only as far as it directly affects the present subject; namely, in regard to the quantity required to maintain the energy of the body, and to supply the daily waste.

To run through the articles of diet in a cookery book, and to discuss each one as to the effects it might have on the economy, would be only wasting volumes of time, and fulfilling a useless task. The multitude of dishes supplied to us by a skilled cook are found to consist of constantly recurring elements, done up in different fashions and with different flavours, but capable of being reduced to four or five elementary substances: it is to these we are driven whereby to gain a knowledge of what we eat and drink.

In the following tables, only the main elements of food are dealt with; and approximate calculations are given, so as to get the amounts as nearly in round numbers as possible. For different kinds of food, their properties and nutritive belongings, see article "Food." Space will only allow of a meagre summary here.

Table I. sets forth the total amount consumed by our bodies— "ingesta," and the total amount given off from our bodies—excreta, or "egesta," in twenty-four hours.

TABLE I.

Ingesta.	Grains.	Egesta.	Grains.
1. Food (water-free)	8,000	1. Solid matters	14,500
2. Water (taken as fluid and combined with food)	36,500	2. Water	40,000
3. Oxygen (derived from the air during breathing)	10,000		
	54,500		54,500

But food is never eaten as "water-free" food, but with the water nature supplies with it; and the two chief elements to which we have to devote our attention in the "egesta" are carbon and nitrogen, hence—

TABLE II.

Ingesta.	Grains.	Egesta.	Grains.
1. Food (with water naturally combined)	21,600	1. Carbon	4,000
2. Water (taken as fluid)	22,900	Nitrogen	300
3. Oxygen	10,000	Other solids	10,200
		2. Water	40,000
	54,500		54,500

The problem, then, is to supply a diet that will yield 4,000 grains carbon and 300 grains nitrogen, as these are the amounts of daily loss.

Now, solid water-free foods are resolved into the following elements :—

TABLE III.

Elements of Water-free Food.	Grains.	Lbs. oz.
Proteids, or Albumen ($C_{72} H_{112} O_3 N_{18}$)	2,000=	about 0 $4\frac{4}{5}$
Starches ($C_6 H_{10} O_5$) and Sugars ($C_{12} H_{22} O_{11}$)	4,400=	„ 0 10
Fats ($C_{57} H_{104} O_6$)	1,200=	„ 0 $2\frac{5}{7}$
Minerals	400=	„ 0 $0\frac{7}{8}$
	8,000	„ 1 $2\frac{2}{7}$

The letters C, H, O, N, refer to carbon, hydrogen, oxygen, and nitrogen; it will be observed that nitrogen occurs *only* in albumen. The numbers by the side of the letters indicate the proportion of elements in each combination.

Nitrogen is supplied by albuminous food alone; that is, by all the tissues and products of animal life, and by the tissues of plants.

Carbon is derived from all the tissues and products of plants and animals.

Albuminous bodies, such as flesh, do not contain carbon and nitrogen in a proportion relative to our wants; thus were we to eat too much flesh, we should have an excess of nitrogen in our diet. So, on the other hand, were we to eat an excess of bread or potatoes, we should have too much carbon in our diet. Therefore it is necessary to have a mixed food. Instinct has led us to choose our food and to regulate our diet, and we shall find that we are in health when we obey the law that prompts us to take food which supplies 4,000 grains of carbon and 300 grains of nitrogen.

The following table sets forth the amount of ordinary simple food as we know it, and also the amounts of the chief elements (carbon and nitrogen) yielded by each.

TABLE IV. (*Calculated from Huxley's Table.*)

Ordinary Food.	With Combined Water.	Nitrogen.	Carbon.
1. Flesh	5,000 grains.	120 grains.	763 grains.
2. Bread	6,000 ,,	70 ,,	977 ,,
3. Milk	7,000 ,,	48 ,,	480 ,,
4. Potatoes	3,000 ,,	7 ,,	348 ,,
5. Butter	600 ,,	·25 ,,	375 ,,
	21,600 ,,	245·25 ,,	2,933 ,,

At a glance it will be seen that this table is deficient in both nitrogen and carbon; hence it is necessary to supply a fuller diet than the above when a man is engaged at very hard work. The following would meet most of the requirements for a man of average height (5 ft. 8 in.) and weight (11 stones, *i.e.*, 154 lbs.).

TABLE V

Diet in Hard Work.	Grains.	Lb. oz.	Nitrogen.	Carbon.
1. Flesh	7,000	about 1 0	160	1,024
2. Bread	10,496	,, 1 8	120	1,676
3. Butter	655	,, 0 $1\frac{1}{2}$	·3	450
4. Potatoes	5,143	,, 0 12	12	588
5. Milk	4,370	,, 0 $9\frac{5}{14}$	10	100
6. Sugar	437	,, 0 1	0	187
	28,101	,, 4 $0\frac{1}{7}$	302·3	4,025

This is almost the right quantity of food required for the daily supply of 300 grains nitrogen and 4,000 grains carbon.

To discuss fully the digestion of food, and the organs whereby the process of digestion is performed, would be to write a physiological text-book. As this is foreign to the object of this article, let it suffice to say that food, after mastication, is acted on by various digestive fluids—viz., the saliva, gastric juice, bile, pancreatic secretion, and the intestinal juice, until it is rendered in a fit state to traverse the delicate walls of the fine absorption vessels (lacteals) in the wall of the intestine. From hence it is carried by the thoracic (lymphatic) duct up to the root of the neck and poured into the blood. The nutritive materials require oxygen for their combustion; and this is, as we have seen, obtained from the air around us by the act of breathing. The blood, rich in nutritive materials and oxygen, is conveyed to the tissues and organs of the body.

They use and consume these, every organ using them in its own way, some secreting precious digestive fluids out of it; some converting it into motion, as in the muscles; and almost all, at the same time with other functions, producing heat. From these organs the blood flows back to the heart by the veins, carrying with it the waste products of their activity. The excretions also must be got rid of, and for this purpose special organs—the kidneys and lower part of intestine—are set aside; whilst the skin and the lungs, although having other functions assigned to them, assist largely in excretions. So that there are four primary organs by which the waste products are got rid of: the kidneys, skin, lungs, and bowels. The bowel provides for the elimination of the undigested parts of the food, and for the waste products that result from intestinal digestion. The quantity excreted thereby is considerable; but in the meantime let us look to the matters given off by the skin, lungs, and kidneys. Although these organs differ much in relations and apparent construction, they allow of the passage of excretory products through the walls of the fine blood-vessels exposed on their free surfaces. These consist of water, carbonic acid, and urea. The skin is chiefly concerned in eliminating water; the lungs, carbonic-acid; and the kidneys, urea. Each, however, partakes in the excretion of the others; thus the lungs excrete not only carbonic acid gas, but water in quantity, and a small quantity of urea; and so with the others. The water and carbonic acid we understand something of, but what is this substance urea? It is represented by the formula CH_4ON_2, showing that it is composed of carbon, hydrogen, oxygen, and nitrogen. It is, then, a product of nitrogenous substances, and the chief means by which nitrogenous waste products leave the body. It is an all-important excretion in connection with muscular work especially, and by and by we shall have to discuss it in reference to that.

We have, then, organs by which food is converted into force, and organs by which the waste products are removed.

Too great a quantity of food will hamper the action of the digestive apparatus, produce less force, and overload the excretory apparatus. Too small a quantity of food will not sufficiently stimulate the digestive apparatus to good digestion, will reduce the production of force, and check excretion. It is evident, then, that the supply of food must equal the demand of the body, and that the eliminating organs provide for a sufficiency of excretory work but not for a plethora. To attempt to understand the proper balance to be maintained between food and excretion, without taking into account the forces expended in digestive work, the production of heat, and muscular force, would be to fall into grievous error. It is necessary, then, to see in what way the forces produced in the body are expended.

I. *Visceral work:* by this is meant the work done in the body by the organs concerned in digestion, circulation, respiration, and nervous energy. Sometimes it is spoken of as "internal work," or "metabolism." The amount of this work is enormous; the ceaseless activity of the heart and blood-vessels, the constant chemical change going on in the tissues, the uninterrupted act of breathing, and the daily expenditure of nerve force—one and all build up a production of force which is appalling to contemplate. The method of estimating the amount of work done is by ascertaining the force required to raise a given weight for a given distance. Thus the force required to raise one pound to the height of one foot is called a "work unit," and the force expended is called a "foot-pound;" so the force required to raise one ton one foot is called a "foot-ton." Now the total amount of force daily expended by a man weighing 154 lbs. (11 stone), has been estimated at 3,400 foot-tons, and of this amount 260 foot-tons are relegated to visceral or internal work.

II. *Muscular work*, as bestowed on external or mechanical movements, amounts, in a man working a moderate day's work, to 300 foot-tons. This, of all the means of expenditure of force, is the most variable. What a difference is there between the work done by a lady, who believes herself to be, and can afford to be, "delicate," and that done by a bricklayer. Still the bricklayer may only expend the amount necessary for health with all his hard day's work; whilst the lady in question, expends only sufficient muscular energy to bear her from her room to her carriage and back again, and from one room to another to her meals. The expenditure in one case is estimated at 300 foot-tons; that of the other at as many pounds. Every one is familiar with the story of Abernethy's patient, who, coming in a carriage to consult him, was told to walk more; the delicate lady, however, said she could not; whereupon the carriage was surreptitiously ordered off, and the patient had, to her chagrin—but to the benefit of her health—to find her way by her own exertions. She found the benefit therefrom, and being a wise woman, took the lesson to heart, and acted on it. Supposing this energy is unexpended, the whole of the body gear is thrown out of order—the muscles become fatty, the heart impaired in its action, exercise becomes more and more difficult, and by and by impossible; and the unexpended energy is like a restless prisoner, determined to escape by bye-paths or by new passages not consistent with health. The amount that can be expended by muscular exercise is immense. Imagine the force required to walk 110 miles in twenty-four hours, or say 500 miles in six days, as has been done in walking competitions of late years. Now, it is calculated that walking one mile on a level road is equivalent to raising seventeen tons one foot in height—*i.e.*, seventeen foot-tons. Multiply that by 110, the distance that has been done in twenty-four hours, and the enormous amount of 1,870 foot-tons is the result; whilst 500 miles in six days means an expenditure of 8,500 foot-tons. That is, perhaps, the greatest amount of muscular work ever performed by any human being except Captain Webb's great Channel swim. The good that comes of great exertions like these is doubtful; but if it do nothing else, it encourages exercise, and shows the strength inherent in our frames. The excessive expenditure over and above the 300 foot-tons stated as about the normal and proportionate amount for an eleven-stone man must be injurious; so that whether the amount of energy put forth falls short of, or exceeds, a just and due proportion, they are both prejudicial to health and long life. The condition might be compared to the flame of a lamp, which, whilst it consumes the proper amount of oil, is bright, and the light is good, but when too much is being supplied the flame becomes smoky, and when too little the light is bad. Each one for him or herself must find out what the amount of exercise required is, and having found it out, act upon it, if they wish to keep their complexion, like the flame, bright, or their health, like the light, good.

III. *The production of heat* is sometimes spoken of as calorific work. This is the third and last of the great means of expending energy, and we have, out of the 3,400 foot-tons which are regarded as the amount expended on all forms of work by the human body, kept a large proportion for heat-producing work. The amount estimated as spent on internal work and muscular exertion was 260 and 300 foot-tons respectively, together amounting to only 560 out of the total 3,400. We have, accordingly, 2,840 foot-tons left as the amount spent daily in producing heat. Where is heat produced in the body? Everywhere, and by almost all tissues. In almost every tissue chemical change is going on, as shown by the presence of the fine capillaries carrying blood—*i.e.*, oxygen. The process of oxidation, the production of urea, water, and carbonic acid, is being done at every spot in the body and at all times. Some tissues carry on the process much more actively than others, and were it not for the blood that, getting heated by the process in one part, carries the warm fluid away to another less warm tissue, there would be an unequal temperature in different parts of our bodies. This, however, is not the case, and we find that there is but little difference between the heat in one part and another, and between the temperature of the skin or mouth and the internal organs of the abdomen. Heat is also produced by every muscular movement. Just as the break on a railway carriage wheel, when tightly applied, causes sparks to issue, so the sudden contraction of a muscle produces heat according to its rapidity of contraction; or, as a long run causes the wheel of a railway carriage to get hot, so long-continued muscular action generates heat. By elaborate calculations it has been found that to raise the temperature of water 1° Fahrenheit, an expenditure of force equal to raising one-third of a ton one foot is required; and were we to apply this to explain the temperature of our own body, which is 98½°, we should find that about 30 foot-tons would be all that is required. But we have seen that 2,840 foot-tons are necessary. Where, then, is the fallacy? It is that we make no provision in our calculation for the expenditure of heat. The average temperature of the air in this country is 49° Fahrenheit, and the temperature of our bodies is 98½° Fahrenheit, that is, nearly 50° more. Heat must then radiate from our bodies, and the lower the temperature the more heat will be lost, and *vice versâ*. The colder the climate, the more heat will be required to be produced; and so foods that produce the greatest amount of heat, such as fats and oils, are consumed by northerly nations, whilst tropical peoples are content with less heating substances. Now the organs by which heat is lost to our bodies are: the skin, the lungs, the kidneys, and the bowels. The two first are by far the more important, and the skin the most highly of all. The amount of blood supplied to the skin is determined by the temperature of the air around, being lessened when the external temperature is low, increased when high. When the blood is brought to the surface in quantity the skin becomes active, perspiration takes place, and the surface of the skin is covered with moisture, which, by its evaporation, causes cooling of the body. The heat of the body is expended by radiation and conduction from the skin and in converting the perspiration into vapour; these are the principal means by which the individual is kept cool.

The force engendered in the body by different foods is a subject concerning which much investigation has been undertaken of recent years. One of the methods by which evidence could be gained is by supplying any individual with a given quantity of carefully-weighed and analysed food, so that the composition is exactly known, and then testing the amount of work that can be got out of the individual fed on such food. This is the most direct means, although not the most reliable; so many other things enter into the calculation. Still, it is a great point to know that experiment and scientific investigation largely bear out what experience and observation have for centuries caused people to believe to be true.

The relationship between motion, heat, and force have already been discussed; suffice it to be said here that physicists have calculated out carefully the relationship between a given amount of food and the force it produces. The process of thought is a follows :—A piece of dry albumen—*i.e.*, albumen deprived of its water—is burned in oxygen. The degrees of heat, called the "units of heat," engendered in the process are carefully observed. The means by which "units of heat" are converted into "units of motion" were previously stated. We are, therefore, able to calculate the "units of motion" engendered by burning a given quantity of oxygen. The same can be done with fats and starchy foods. What, then, do we find?

15 grs.	of dry albumen	yield about	. .	13,851 foot pounds.
15 ,,	fat	,, ,,	. .	27,716 ,,
15 ,,	starch	,, ,,	. .	11,722 ,,

Now, the amount of force produced daily for all kinds of visceral and muscular work and the production of heat was 3,400 foot-tons, or 7,616,000 foot-pounds. We see how much 15 grs. of each substance produces; hence, when we take the quantity consumed daily, we can calculate out the amount of force that each substance yields daily.

The quantities given were: albumen, 2,000 grs.; starch, 4,400 grs.; fats, 1,200. Hence, the force values of the total amounts are—

	grs.		foot-pounds.		foot-tons.
Albumen . . .	2,000	yield	1,846,800	=	about 824
Fats	1,200	,,	2,217,280	=	,, 989
Starch, &c. . . .	4,400	,,	3,437,866	=	,, 1,534

Applying this rule to the diet scale given in Table V., we can calculate out the amount of energy and force supplied by each substance.

The force is represented in "foot-tons," which was previously explained to be the force required to raise one ton one foot from the ground.

TABLE VI.

Diet for Hard Work.	Grains.		Foot-tons.
1. Flesh	7,000	yield	880
2. Bread	10,496	„	1,342
3. Butter	655	„	420
4. Potatoes	5,143	„	456
5. Milk	4,370	„	80
6. Sugar	437	„	275
	28,101		3,455

Now, 3,400 foot-tons were shown to be the amount spent on visceral work, heat, and muscular energy; so that the amounts given in Tables V. and VI. are almost exactly what are wanted for supplying the daily waste of carbon and nitrogen, and the total amount of energy for all bodily work.

The times at which food will be most conveniently and most beneficially taken are as follows :—

I. At the time of getting up in the morning, say six or seven, drink a tumblerful, *i.e.*, about a ½-pint of cold water. This should be taken after the mouth has been well swilled out with water, and perhaps the throat gargled. With some people, however, cold water in the morning causes a depressing and heavy feeling in the region of the stomach, which lasts for an hour or two, and deprives the early riser of the anticipated enjoyment attendant on early rising. When such a condition ensues it will be found better to take a glass of milk, or, what is better, a teaspoonful of Swiss milk in a teacupful of warm water. To this a wholesome biscuit, about 1 oz. in weight, is a very grateful and satisfying addition.

II. At breakfast, say at nine o'clock, one or other of the following ought to be sufficient :—

(*a*) A couple of eggs, and a medium-sized or small sole fried or boiled—boiled is the more digestible.

(*b*) Or a couple of eggs, with a devilled wing or leg of a fowl.

(*c*) Or one egg, with a fat chop well done.

(*d*) Or a well-done rump or fillet steak.

(*e*) Or two eggs, with bacon or ham. Bread to the amount of one and a half or two good thick slices of stale or aërated bread, with a fair amount of butter. Coffee, made by the Munich apparatus, and limited to one cup, in the proportion of one-fourth coffee and three-fourths milk, is by far the best fluid for breakfast. If coffee cannot be taken, try cocoa, or even chocolate, with plenty of milk. Avoid tea if possible. Tea should be taken at "tea-time," and not at breakfast. Milk is not a good substitute for coffee and milk. If none of these can be well taken, a tumblerful of Apollinaris water or salutaris water, or some such simple and pure water, should be taken instead of tea. Potash and soda water should be avoided, as being too depressant in their action and variable in their composition. After breakfast is the best time to eat whatever fruits are in season. The best for a man in training are—grapes, rejecting both the skin and the stones; oranges; figs; and pears quite ripe.

III. At luncheon-time, say one o'clock, the following ought to be sufficient:—

(*a*) Devilled fowl in rice.

(*b*) Or a chop, steak, or a couple of cutlets well done.

Half a slice of stale bread; two medium-sized well-boiled potatoes; a glass of cold water, or Apollinaris, or salutaris, or some such water. Avoid curries and new potatoes.

IV. At tea-time, two cupfuls of good tea (first infusion), with milk and a *little* sugar. With tea, a slice of bread-and-butter, or a wholesome biscuit should be taken. The "tea-time" is between four and six in the afternoon—five is the usual hour.

V. At dinner-time, say seven o'clock, one in training must be most careful.

(*a*) As a rule, avoid soups.

(*b*) Plenty of fresh boiled fish may be eaten. Salmon and shell-fish are to be avoided.

(*c*) Eat meat cut from the joint, and avoid *entrées* and *entremets.* Eat with meat one or two well-boiled potatoes, and cauliflower, cabbage, &c., and a slice or two of stale household bread.

(*d*) Sweets, such as pastry, should be avoided; but cornflour, rice, baked apples and pears, and bread-and-butter puddings, may be pretty freely consumed, if there is any great desire for them.

(*e*) Cheese, against which there is such a prejudice, but which, in spite of the bad name that it gets, finds its way into the dietaries of almost all peoples, may be indulged in moderately with impunity, even in the case of a person in severe training. It is highly nutritious, but when taken at the wrong time it is difficult to digest.

(*f*) As dessert, grapes, oranges, figs, and bananas may be indulged in, but the morning is the better time for the consumption of these. Avoid nuts of all kinds, except boiled or roasted chestnuts.

A small cup of black coffee, with or without milk and sugar, but with the least bit of the latter, is a capital aid to digestion after dinner.

(*g*) Drink water, two tumblerfuls, during dinner, or if beer suits, a pint of mild (Anglo-Bavarian) ale; or again, one tumblerful of water during dinner and a like quantity of ale or stout with cheese. Wine should never be given unless symptoms of "training off" appear. Then, and then only, should a wine-glassful be given during dinner.

VI. At the time of going to bed, say eleven o'clock, a breakfast-cupful of oatmeal gruel, made with milk, is a safe and highly beneficial means of inducing sleep. Instead of gruel, oatmeal porridge with milk, made and eaten as in Scotland, not as in England, is a fairly good substitute.

Should it happen that, instead of taking exercise in the afternoon, as usual, it is taken in the *evening*, then the times of feeding must be changed. The mid-day meal should be "dinner," and in the evening, at say nine, supper should be taken after exercise. It should consist of light food, but, at the same time, something pleasant and tempting, as in the evening, coming home tired, it is difficult to set the digestive organs to work. Food when taken "with a will" is more speedily digested than food taken simply as a duty. Setting to work to eat cold meat at nine o'clock at night does not present the most " teeth watering " diet, and is consequently anything but digestible. When one comes in to a cold supper, one's eye wanders over the table to see if there be anything to take off the monotony of cold boiled chicken or a piece of cold mutton. The sight of a baked potato, for instance, immediately alters the aspect of affairs, the spirits brighten, the saliva can be felt to flow in the mouth—*i.e.*, " the teeth water ;" and although it is impossible for one to appreciate the fact, it is known by experiment, as previously shown, that all the digestive fluids flow at the sight of tempting food, just as the saliva in the mouth. Let one despise these things at one's peril; sooner or later the obstinacy in such matters will tell. The trainer who will not allow of such things will find his men dyspeptic, spiritless, and unfit for a plucky spurt when the necessity arises. Weight and stature are, perhaps, too much thought of in the judging of the qualities of men for rowing, running, riding, and the like. Could an estimate be formed of their animal spirits, it would form a valuable addition to the weight and stature knowledge, so accurately given before any race or athletic competition. What a difference there is between a horse with and without " blood ;" just such a difference is there between men and bodies of men, and on such a difference does the winning or losing depend.

Take care, then, of feeding at all times, but especially when training, and do not bring home a man weary and fatigued to a heartless meal. The best form of supper is a slice or two from a cold well-done round of beef, with a *small* baked mealy potato, with butter and stale bread. A spoonful of cold bread-and-butter pudding to follow will be grateful and easily digested. Drink water, a tumblerful or two, or any of the simple sparkling waters—such as Apollinaris, salutaris, &c.

To those who crave for porridge, a large basinful, made as it should be made, and taken with plenty of milk, is a light, wholesome meal, and a good one to sleep on. When porridge with milk is eaten, take plenty of it, but take nothing else.

WALKING.

The process of walking is as difficult to understand as it is simple to perform; as hopeless of clear explanation as it is common in its performance. Let the reader stand up and go through the following steps :—

I. Stand erect with the heels together, and the toes slightly turned out.

II. Advance the left foot (for the sake of the better understanding) a short distance, so that the heel of the left foot is on a level with the big toe of the right foot, and six inches to its left. It will be felt that on doing so the whole of the weight of the body is sustained by the right leg.

III. Throw the weight of the body gradually forwards. It will be felt that the weight gradually leaves the right foot, and comes to be sustained by the left. At the same time, the muscles on the outer aspect of the left hip, and those of the calf of the right leg, are felt to become active, the first set having a pulling action, the latter a pushing; the whole body, or the pelvis—*i.e.*, the haunch-bone—having an inclination to the left.

IV. Throw the body further forwards; the weight comes to be much more sustained by the left foot, the right foot touching the ground only opposite the ball of the great toe.

V. The whole of the weight is now sustained by the left foot, when the muscles in front of the left thigh, in front of the leg, in addition to those on the outer aspect of the left hip, are all found to become tense and active; whilst the toes of the right foot are raised from the ground by the muscles in front of the right leg.

VI. The right lower limb is now swung forward, and the repetition of the same process constitutes walking.

It will be observed that the body, with the short step prescribed above, has a considerable side to side, or lateral motion, resembling in a moderate degree the long swinging gait of advancement practised by the skater. The centre of gravity alternately sways from side to side. This may be done in one of two ways:—(*a*) Either by pushing out the pelvis (the haunch bone) towards the advancing side, and thereby causing a plunging, swaying, or rocking motion; this is an awkward gait, and one frequently observed in the walk of women, caused by the breadth of their pelvis, a motion one follows naturally when walking very slowly; (*b*) or by a gradual inclination of the lower part of the trunk, from the level of the shoulders downwards, so that there is a more graceful carriage, and a less bobbing and swaying motion. Men can walk more gracefully than women, from the fact of their possessing a narrower pelvis (haunch bone), and the consequent better adaptation of the lower extremities for locomotion. The difference in gait may be accounted for thus:—On account of the breadth of the female pelvis, the heads of the thigh bones are held widely apart. The knees consequently appear to come suddenly together, causing slight "knock knees," and the inside of the foot is trod upon, causing a slight splay, or "flat foot." The lower extremities of a female are, then, as a rule, neither beautiful, nor useful for extreme muscular work. The gymnastic performances undertaken by women are generally confined to the trapeze, cross-bar, and the like, necessitating the use and development of the upper limbs; but such sports as running, jumping, walking, &c., are not, and cannot be, undertaken with hopes of success, owing to the conformation of their lower extremities.

In the above attempt at an explanation of the process of walking, no reference was made to the "*length of the step.*" Now, every one has his own particular step, caused by the conformity, shape, and length of his bones, and the height of the body. One can recognise the step of a friend by *hearing* the tread, and at a distance the *gait* of a friend will often assure one that it is some particular individual of one's acquaintance. Hence, there is a natural step for each individual to fall into, and it is fallen into quite involuntarily. Such a thing, then, as a regulation step must be unnatural, and any attempt at equalising the step of different individuals of different heights must be a loss of power. In the march of soldiers, however, men are made to take a regulation step, and young and old, tall and short, have all to take the same length of step. The drummer-boy has to stretch his legs to the utmost, and the man of six feet has to restrain the natural swing of his limbs, so as not to outstrip his shorter comrades. The step of 30 inches, which is laid down as the regulation step, is adapted for men of above 5 feet 8 inches in height. The men in a regiment who are taller and those who are of less stature have to adapt their steps accordingly; necessitating extra muscular exertion, and causing fatigue at an earlier period than if each were allowed to choose his own. As this is impossible from a military point of view, it comes about that regimental marching is slow, and the greater the body of men, the more slowly will the distance be covered.

The *rate* at which the steps are taken will of course affect the distance covered, and the amount of muscular energy put forth. The number of steps taken by British soldiers is 116 a minute when marching "quick time," and 75 a minute when "slow time" marching is practised. The *swing of the body* natural to every one is restrained by most people, as it is considered ungainly and vulgar. This restraint, however, causes a great loss in power, and most markedly in regimental marching, where the swinging motion is reduced to a minimum, the men having to march straight forward in the position of "attention."

The *height* the foot is raised from the ground should be left to the individual in easy walking, but in some cases soldiers are made to lift their feet high from the ground for the sake of appearance. An enormous loss of force is thereby incurred and such men are unfit for long marches.

From all these facts it is gathered that when one wants to walk quickly, or to cover a long extent of ground quickly, as in a "*long-walking*" competition, the length of step, the number of steps taken a minute, the gait, and the height the feet are raised from off the ground, should be left to each individual. What must be instilled into any competitor are the following points, viz.:—

1. The method of walking "*from the hips*," as it is called, that is, extending or straightening the limb, and swinging forward the whole limb from the hips. The length of stride is thereby increased over and above what could be obtained in walking "*from the leg*," *i.e.*, flexing or bending the knee and ankle at every step. The muscular energy expended by the latter method will necessitate a great amount of muscular energy, which will tell fatally on the success of long-distance walking.

2. The method of preventing flexion of the knee and ankle taking place may be either by an effort of the will or by mechanical restraint, such as long boots When the will is brought into play to restrain muscles, the expenditure of force is nearly as great as is the permitting of their action; hence, it must be done, if at all, by boots, gaiters, or leggings. Long boots (Wellington's), when well made, and of the best leather, are perhaps the most serviceable in walking competitions. For ordinary long walks, "ankle boots," such as those worn by soldiers, are the best. Shoes and gaiters may be used also, after the style of the soldiers of a Highland regiment. In hill-climbing, shoes and high gaiters are best, as the knees and ankles ought to be free for flexion and extension. In walking competitions all sorts of appliances are used, tights are worn as high as the hips, and Wellington-boots over the trousers. Elastic knee-caps, and shoes with gaiters, are used by others; and as the competitor finds a weak spot here or there, or a giving way of any joint, some fresh contrivance is employed, according to the ingenuity of the individual.

In the article on Dress, shoes and boots are fully discussed; therefore, suffice it to say here that boots must be—(1) Wide-soled, *i.e.*, the soles should project "beyond the uppers" when the weight of the body is placed on the foot. (2) The sole should be, in indoor walking competitions, a single sole; but in out-of-door walking a thick double sole. (3) The heel should be sufficiently low. (4) The boot must be just long enough. The last two points are of importance in this way; if the boot is too long, a great deal of inconvenience results, as the push-off from the toe is impeded, and the foot has to be raised higher, to prevent the long point touching the ground. The heel ought to be low and broad, for the purpose of giving a more firm support than a high and narrow heel can, and also for the purpose of allowing the advancing foot to be placed on the ground as nearly flat as possible. Too low a heel must also be avoided, as the strain therby incurred on the muscles of the calf is greatly increased. The heel for a double-soled boot ought to be one inch in depth, and for a single or thin soled boot just over half-an-inch. (5) The boot must be waterproof and supple. Various appliances are used to render the "upper" waterproof, such as rubbing the boot with linseed oil, fat, or butter, especially at the sewn parts; or the following mixture may be used:—Take half-a-pound of shoemaker's dubbing, half-a-pint of linseed oil, and half-a-pint of solution of india-rubber. Dissolve with gentle heat (as the mixture is very inflammable), and rub on the boots. Sportsmen find that where the water enters is along the tongue of the boots and through the eyelets for the passage of the lace. This can be nearly prevented by having the boot made as a soldier's boot is, viz., with flaps at the sides, with the tongue continued up between and of the same piece as the upper of the boot. The water, when it enters, runs out beneath the flaps. For the lace, holes in the leather without eyelets should be used. When one gets amongst wet grass, or turnips, or heather, it is much better to turn down the trousers at the feet than to turn them up. A gamekeeper, or Scotch gillie, invariably does so, preventing the wet getting over the top of the boots, or entering the holes for the lace. (6) Never start to walk any distance in new boots or shoes. Every one has had experience of the misery of blisters and corns resulting therefrom.

The amount of energy expended during walking.—We have seen that each muscular act is the expenditure of so much force, and we expressed the amount in foot-pounds and foot-tons. We saw the methods by which calculations of the expenditure of energy were effected, and it was taken as a fact that 300 foot-tons of external energy is an average day's work for a strong healthy man, weighing about 154 lbs.—*i.e.*, 11 stones.

It is calculated that walking 1 mile is equivalent to the raising of 17·67 tons one foot, &c., thus:—

Distance.	Number of tons raised 1 foot.
1 mile	17·67
5 ,,	88·35
10 ,,	176·7
20 ,,	353·4

At this rate, 17 miles would have to be walked daily to give such a man 300 foot-tons of work to do daily. The minimum of work that ought to be done by a healthy man is 150 foot-tons, necessitating a walk equivalent to about 8½ miles. The distances required for health will vary according to the employment of each individual; should one's daily occupation be standing or walking, it is evident that a *shorter* "constitutional" walk will be required than when sedentary work is engaged in. The answer to such suggestions as these, in regard to the amount of walking, by men in business is, that it is impossible to find time to do 8½ miles a day in walking. How long will it take to get through the distance?—two hours and a half. Let the city man walk to his office instead of driving or coming by train; if he lives a long way out of town, let him walk to a station three or four miles off, instead of having his house so "handy" for the train. It is handy for something else—viz., gout, indigestion, bronchitis, asthma, and long doctors' bills.

The force calculated as being expended in walking a mile is made without any notice being taken of extra weight carried. Supposing a great-coat be added to the clothing, that means an additional weight of, say, five pounds, to be carried. A small hand-bag, containing, say, a book or two, a bundle of papers, or it may be a dress-suit of clothes, will add immensely to the force that has to be expended. A hand-bag, with personal necessaries, will weigh about six pounds; the same, with a dress-suit, about eight pounds. Supposing, then, a great-coat weighing five pounds, and a hand-bag weighing seven pounds, are carried during a walk, twelve pounds is added immediately to the amount to be carried; necessitating an expenditure of a force capable of raising 1⅗ tons through one foot for every mile, so that, with a weight of twelve additional pounds, the energy expended in foot-tons would be—

Distance.	Foot-tons.
1 mile	19·07
5 miles	95·35
10 "	190·7
20 "	381·4

It is evident, then, that the greater the weight carried the more force must be expended; and when the weight comes to be, instead of 12 lb. as given above, 60 lb., the weight of a soldier's complete kit, the difficulty in marching and the explanation of the short distances covered by an army on the march is easily understood.

Distance.	Foot-tons.
1 mile, carrying 60 lb.	24·75
5 miles " "	123·75
10 " " "	247·5
20 " " "	495·00 *

This is an enormous expenditure of force, and such work as 20 miles a day with such a load cannot be long endured. This is no doubt an under-estimate of the work performed, as the calculations are made from observations on men walking on the level. In walking competitions, such as those performed at the Agricultural Hall, London, and in other parts of the country, the distances performed have been enormous. It must be remembered, however, that such performances were conducted indoors, that the weight of clothing carried was reduced to a minimum, that the ground was pleasant to walk on and level; the heat of the sun did not interfere with exertion; there was no head-wind to delay progression, and a change of boots, stockings, &c., could be had at a moment's notice; so that the amount of force expended per mile was fractional compared with the soldier's march, with a 60-lb. load under a hot sun, or with a strong head-wind, and, may be, rain or snow, beating him back. The diminution in the weight of clothing would in the case of a walking competition alone reduce the energy expended by about 2 foot-tons in every mile, so that the following table would be nearly correct:—

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* Parkes' Manual of Hygiene, p. 389.

Distance per diem.	Foot-tons.
1 mile	15
10 miles	150
20 ,,	300
50 ,,	750
100 ,,	1,500
120 ,,	1,800

This, of course, cannot be kept up. Any man expending much more than 300 foot-tons of energy a day will come to a standstill after some time, and a day or two's rest will be required to recuperate. Soldiers over-marching for a day or two must have a rest for a day or part of a day afterwards.

By some of the competitors in Weston's walking-matches 120 miles have been accomplished in the first 24 hours, implying the expenditure of 1,800 foot-tons. During a week's walk 520 miles have been covered, necessitating an expenditure of 7,800 foot-tons. This is perhaps the greatest amount of energy ever expended by a human being in a given time.

The moment walking comes to be *up-hill*, the fatigue is increased. The centre of gravity of the body is changed, and the muscular force necessary to provide for the change causes a fixing of the diaphragm (midrif), and a rigid condition of many muscles. The breathing is interfered with, owing to the fixing of the diaphragm, and the heart becomes affected thereby. A person with a sensitive diseased heart can, during a walk, tell when a rise in the ground occurs which is well-nigh imperceptible. That the climbing a hill or going up-stairs is an increased muscular expenditure there is no doubt, but we make it more exhausting from the habit we have of suspending free breathing. Let the reader *hold the breath* and run up 24 steps of a stair, and then perform the same act *breathing freely* and deeply. It will be found that by the first act marked breathlessness will be induced, whereas by the latter the effect is much less marked. So it is with any muscular act that requires fairly long continuance. Unless the breathing be performed freely, fatigue must soon occur. It is the management of the breath in running, rowing, &c., that constitutes the difference between the beginner and the experienced athlete. That the muscular force expended on going up-stairs is great will be seen from the following table. Assuming the steps of a stair to be 6 inches in height, and allowing the weight of the body to be 154 lb., *i.e.*, 11 stones, the force expended would be as follows :—

Number of steps 6 in. high.	Foot-lb
1 step	77
12 steps	924
24 „	1,848
48 „	3,696
70 „	5,390

This last represents nearly 2½ foot-tons, and is not a longer stair than is found in most large houses in our cities. A servant-girl may have to run up twelve steps twenty times a day to answer the door, &c., expending thereby about 16 foot-tons of energy. The amount in tons does not represent the amount of fatigue induced from the rapidity with which the act of going up-stairs is usually performed; and the rate is an important consideration, owing to the strain thrown on the heart and lungs.

The Effects of Walking on the Body and on the Health.—Walking is the chief means whereby exercise is obtained by the bulk of the community, and, being so, we must discuss its effects pretty fully. What are the effects of a brisk walk apparent to one's self? The colour comes to the cheek, the temperature of the body is raised, the breathing becomes quickened, the pulse, were one to feel it, is increased in frequency, and the skin becomes moist; the appetite is increased and digestion improved. Most of the muscles in the body are kept active by walking; all, in fact, except the muscles of the upper extremities. The body has to be kept erect by the muscles of the trunk, and the muscles of the lower extremity are of course in full activity. The effect of activity on muscles has been fully gone into early in this article, so that there is no need to discuss the subject again. Suffice it to say that by muscular contraction the muscle is increased in hardness, heat is produced, the circulation of blood through the muscle is hastened, the excretion of water, of carbonic acid, and to a slight extent of urea, is increased. The muscle also after a time becomes stiff from fatigue, and the quicker the walk the sooner the fatigue comes on. When one departs from one's natural step to keep step with a friend, or during drill, fatigue is much more quickly induced, as an unnatural call is made on parts of the muscles used, which, not having been employed for a similar purpose previously, become soon exhausted. In addition to the effects on the muscles, important results are obtained as regards *the internal organs.*

Owing to the quantity of carbonic acid coming to the lungs by the veins from the muscles actively employed, the breathing is hastened to get rid of the waste products, and to get an increased supply of oxygen. The increased respiratory process of necessity quickens the heart's contractions, and so the circulation through the active muscles and the body generally is rendered more active. These effects are apparent to every one, but the effect on the digestive organs is not so easily understood. The accompanying diagrams (Figs. 7 and 8) show that as we have the chest organs above the diaphragm (midrif), so we have the stomach, liver, and spleen immediately below and in contact with it. Consequently, at every breath the descent of the diaphragm causes the descent of the abdominal contents, affecting not only the three mentioned, but also the whole of the intestines. When the breath is sent out (exhalation) the diaphragm ascends, and allows of the abdominal viscera again ascending, so that at every breath the abdominal viscera are affected, rising and falling to a considerable extent. Any increase in the rate of breathing will cause an increase in the motion of the liver, stomach, &c., bringing more blood to them, hastening the circulation through them, helping the passage of bile, the passage of the food along the alimentary canal, and thereby improving digestion, and bringing an appetite at the end of the walk.

Look at the diagram once more, and it will be seen that the diaphragm does not pass straight across the body, but that it slopes down behind the liver. A further diagram would show also the spleen and stomach in contact with the diaphragm on the left side. It will be seen at once from the position thus indicated that the diaphragm does not pass straight downwards, but downwards and forwards, squeezing the liver, stomach, and spleen forwards against the abdominal wall. This motion is necessary to help the bile along its passages in the liver, necessary likewise to assist the stomach in the trituration of the food. Animals with no diaphragm have gizzards, that is, thick-walled stomachs, by which to grind their food; but animals possessing a diaphragm have these important digestive organs close thereto, so that the impulse of its contraction may be communicated to them, to help them during activity, thus taking the place of the gizzard. "Laugh and grow fat" is an old experience. "He that laughs well, digests well," has the same significance, and it is more than a superstitious belief when one comes to look into it and considers that laughing is associated with an active state of the diaphragm, thereby compressing and moving the abdominal viscera, as well as filling and emptying the lungs with vigour. The effect of walking on the *breathing* is marked, not only in regard to the rapidity of the respiratory acts, but also as regards the quantity of oxygen inhaled and the quantity of carbonic acid gas exhaled. The ordinary

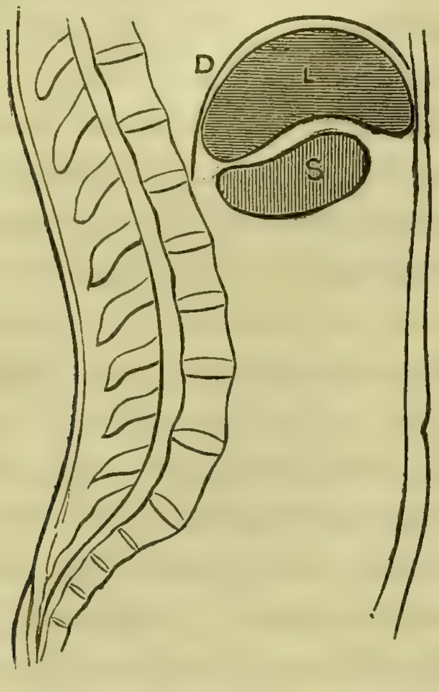

Fig. 7.—A Perpendicular Section of the Body in the Middle Line, Showing (d) the Diaphragm, (l) the Liver, (s) the Stomach.

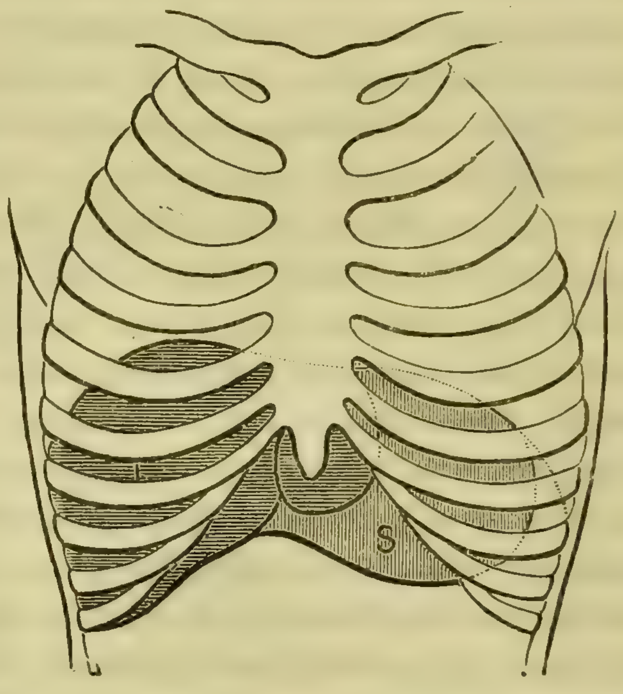

Fig. 8.—A Front View of the Body, showing the position of (l) the Liver, (s) the Stomach.
The upper dotted line, continued into the black line, indicates the position of the diaphragm.

rate of breathing when the body is at rest is about, say, 15 to the minute ; at each breath about 32 cubic inches of air are inhaled, amounting to $32 \times 15 = 480$ cubic inches per minute. Whenever walking is begun, and the rate increased, the amounts changed are augmented, and in the following proportions :—

Walking at the rate of	The air inspired amounts to
1 mile an hour	912 cubic inches per minute.
2 miles an hour	1,320 ,, ,,
4 ,,	2,400 ,, ,,
6 ,,	3,260 ,, ,,

This enormous increase of the quantity of air consumed during exertion will at once bring home a number of lessons. First, that exercise is best taken in the open air, and not in gymnasia ; second, that free play to act for the regions of the chest and abdomen must be given. Most people recognise the necessity of having the chest free, although neither soldiers nor civilians practise it. A soldier's jacket, buttoned up to the chin, is about as bad as it can be for allowing free play to the chest, but it is better than it used to be when the stock was in vogue. The most perfect dress, as far as the allowing of chest expansion is concerned, is that of a sailor of the Royal Navy: in it the chest is encumbered neither by bands nor braces.

We must have gathered, however, from previous considerations, that the motion of the abdomen plays an important part in breathing; it rises and falls at every breath, yet how common is it to find athletes putting a band or support around the soft-walled abdomen ! How common is it to find a labourer with a band like a horse girth round his body to give him support, as he says, and to allow of his lifting weights that he could not otherwise do! This is a death-belt to many a man, causing emphysema of the lungs, asthma, as it is called, from over distension of the lung and the chest; it is the commonest cause of rupture (hernia) so frequent in labouring men ; it prevents the circulation in the veins of the abdomen, causing piles and other troubles. It is to the lower part of the body what a tight garter below the knee is to the circulation in the leg, which must in time cause the veins to become distended (varicose veins). On no account must a *tight* broad or a narrow belt be worn around the soft-walled abdomen—leave that to so-called fashionable women; but let no man, whatever his work may be, wear this death-belt. If a belt is preferred to braces, let it be applied *below* the top of the haunch bone, where the bones can resist the pressure. A sailor's trousers are tight around the hips, *i.e.*, below the top of the haunch bone, where no damage ensues from tight clothing.

The moisture of the skin during exertion calls attention to the fact of its activity. The excretion from the skin must be allowed for, just as is the exhalations from the lungs. What a badly-ventilated room is to the breathing, so is the non-removal of sweat to the skin. The sweat must be removed by frequent change of clothing and by bathing. Flannels next the skin are the best absorbents, and from that very fact they must be frequently changed and washed. Bathing not only removes dirt, but the stimulus of cold water, and the glow communicated to the skin by the process of drying, encourage its action, thereby relieving the internal organs of extra work in eliminating water, carbonic acid, &c., from the body.

The Daily Walk.—This, by many termed the "constitutional," is too often a routine performance devoid of pleasure or interest. To *girls at school* the two-and-two procession is an infliction terrible in its monotony, depressing in its effects, and unless performed in the country, almost useless as regards health. Girls' boarding-schools ought not to be in the centre of large towns, and least of all in the centre of London. Londoners who can afford it, and are wise enough, send the girls of the family to good schools by the seaside or in the country. There it is possible not only to get fresh air, but, what is nearly as important, nice walks. A walk *with an object*, viz., to some view by the sea-shore, to hunt for some shells, to wander in search of ferns, flowers, mosses, and the like; to call at some farmhouse a sufficient distance off to get a glass of milk; to visit some child at the journey's end, and take it a flower or a sweet; to reach some knoll, which at the very least presents something to walk towards. Many other temptations to walk could be devised by any schoolmistress, did she put herself to the trouble to do so.

A town schoolmistress may often be heard to say that it is all very well in the country, but such a thing is impossible in towns; there are only the parks to go to, and they soon become devoid of interest. It is questionable whether such women should be in charge of the rising generation; if a schoolmistress has not ingenuity enough to provide for their out-of-door welfare, she should not be charged with the training of the young. It is as much part of her duty to train the body and the affections as it is to train what she is pleased to call the mind. In towns how many thousands of interesting points are there not to be found! In London the British Museum is regarded as the great bugbear of school-girls' spare moments, simply because their rigid and unsympathetic schoolmistress knows not how to make it interesting. Are there not scattered over London houses rendered famous by individuals who have lived there, whose names, occurring in the girl's history book, would be for ever stamped on her memory by seeing the house in which this man of history lived? She would come to regard the man as a human being, and not as a creature created by her schoolmistress to bother her. Are there not thousands of poor who are starving from want and cold, who would bless the bright girl's face who brought even a dinner-roll or a bit of clothing? Could not her sewing lessons be rendered more interesting from the fact that what she is sewing could, when it is finished, be taken by *herself*, or given by others to the thankful recipient? Ah, no! charity, natural affection, and brightness of behaviour are not included in the "extras," and too often the mistress of the establishment defies interference with what she calls her system. It is with a feeling of helplessness and hopelessness that one tries to point out this curse to our land.

Whatever may be the pastime indulged in by *young men*, walking exercise must never be neglected. The oarsman will become "stale" unless the method of exercise be varied; the gymnast will develope the upper part of his body, and his lower extremities will remain spindle-shanks. So with all other forms of exercise; nothing can supplant walking, and success, in any form of game, sport or gymnastic training, cannot be attained unless walking be freely taken.

With *middle-aged men* walking ought to be the chief means of obtaining health and exercise, and should be indulged in freely. No man under sixty, unless he be kept walking while at his work, or can afford a horse to ride, should walk less than six or eight miles a day, if he wished to keep well and to have healthy children. This is, however, what is *not* done; the City man goes by train or omnibus to and from his place of business all the year round. When his holidays come he hurries off to grouse or partridge shooting, to climb hills or visit distant cities—in fact, he at once goes in for violent exercise; and what is the result? The heart, the lungs, and the digestive organs are at once upset; the birds are missed; sight-seeing presents no interest; and the pleasure anticipated, but not realised, sends him back to town worse than when he left it. A horse taken off the grass cannot be galloped hard without harm; a stall-fed ox cannot pull a plough for any length of time; no more is a man, unaccustomed to long walks or to climbing hills, likely to undertake either with impunity. The heart, the lungs, and the blood-vessels must be so in harmony with each other, and with the muscles, that there is no hitch in their concord of action. What happens when a man unaccustomed to smart exercise first starts on a sudden walking or shooting excursion is this—the blood comes back in the veins from the muscles in greater quantity than can readily pass onwards through the right side of the heart and lungs; the right side of the heart becomes dilated, difficulty of breathing, sighing, and yawning occur; the face presents at first a blue mottled and then a pale appearance; the limbs, especially the ankles, become swollen; or if the heart and vessels are much affected by the decay of age, either one or the other might give way—the former giving rise to instantaneous death, the latter to apoplexy. Let no man getting on in years, therefore, start suddenly on an excursion at which he is immediately expected to undertake severe muscular exertion. If he be not in the habit of walking, let him commence a fortnight or three weeks before, and gradually get himself into condition.

Take an ordinary "City man," working, say, from half-past nine in the morning to five o'clock in the afternoon. Should such a person contemplate a shooting or walking excursion, &c., some such scheme as the following might be followed with advantage:—

1. Get out of bed at a quarter past seven o'clock in the morning.

2. If not accustomed to take a cold bath, sponge first one limb and then another carefully with water with the chill taken off, drying each limb before sponging another; cover up each part as soon as it is dried, so as to expose as little of the body at a time as possible.

3. Take breakfast at 7.45. It may consist of eggs and bacon, or a steak or chop, not steaks or chops. Drink anything except tea or alcoholic stimulant; coffee, three parts milk, is the best breakfast beverage; should this be unsuitable any pure sparkling water is better than tea or milk.

4. Walk to the office if it be a reasonable distance off; if not, take a walk with some object in view, however trivial that object may be. At first a mile and a half, then two miles, and at the end of the week three miles to and from home must be walked. Walk at one's usual pace at first, then increase it to a moderate, and finally to a fairly quick pace—about 3½ miles an hour.

5. For luncheon have a chop, one medium-sized potato, and about a tumblerful of water.

Take no bread at luncheon. If one must have some stimulant, one glass of light ale, or one glass of dry sherry is all that ought to be indulged in.

6. Have two cups of good tea, first infusion, with bread and butter at tea-time.

7. Walk the same distance in the afternoon as in the morning.

8. Get home half-an-hour before dinner, and rest or dress until it is time to dine.

9. Dine not later than 7.30. Eat at dinner wholesome food, and drink not more than two glasses of ale, or one glass of sherry, and a glass of ale or stout with cheese. Two glasses of sound claret may be taken instead of either of the preceding.

10. Get to bed not later than eleven. If troubled with sleeplessness, put on an extra blanket, a cap to cover the head and ears, or take a basin of oatmeal gruel before going to bed. Cold and hunger are chief causes of sleeplessness in healthy people.

If some such care be not taken with the exercise and diet, any man whose life is spent indoors will certainly come to grief by persisting—in defiance of all teaching—to believe that he is still young, and that his system can stand anything. If a man has a garden to work in, let him dig in that if he chooses, but he must never forget to walk some distance daily, although the distance may be curtailed if he does a fair amount of delving.

For men *over sixty* a walk is again the best means of promoting health. The walk must be tempered to the strength, and should be done at nothing more than a moderate pace, if a man wishes to take care of his blood-vessels. Grouse shooting ought be given up for partridge shooting. Fox-hunting in moderation is excellent exercise and sport for a healthy man up to the age of sixty-five. For *septuagenarians* driving is the best means of obtaining exercise.

Running.

Running consists in the taking a series of short, rapid, forward jumps or springs off one foot. The body is actually unsupported for a time by the feet. This constitutes the difference between walking and running : in the former one foot is always on the ground, in the latter the springs throw the body upwards, so that both feet are off the ground. The chief cause of the rapid rate in running is the increased number of steps taken in a given time. The distance covered at each step is not much increased. Soldiers at quick march take a step of 30 inches, and when at the *double,* 33 inches at each step. The *number* of steps, however, is increased from 116 to 166 per minute. This step increases the distance covered from 187 feet per minute in walking to 453 feet per minute in running at the double, or a little over a mile in 11 minutes. But this is slow progression to what one finds in running competitions. The soldier at the double has all his kit and accoutrements to carry, but in running-races the weight carried is fractional and the speed enormous. The fastest on record at which 100 yards have been run is a fraction over nine seconds.

Allow, for the sake of the better understanding, that a runner takes a step of 36 inches, *i.e.*, a yard, at each step—a very common length of step. Now, running 100 yards in 10 seconds would necessitate 100 steps, or at the rate of 600 steps per minute. Again, the quarter mile—440 yards—has been run in less than 50 seconds. Supposing, however, one minute was the time taken, allowing the same step as before, 440 steps must have been taken in one minute.

Again, one mile (1,760 yards), has been run in 4 minutes 22 seconds. Supposing 5 minutes to be the time taken, 1,760 steps must have been taken in that time, or at the rate of 352 steps in one minute.

It will be observed that the number of steps taken per minute diminishes as the distance increases. The increase in the number of steps taken a minute is evidently the greatest gain as far as speed is concerned; but when long distances have to be run, the length of the step is the important element in attaining success. Short and long steps cannot be taken at the pleasure of the individual without loss of power. A short man has a step natural to himself, and it is of necessity shorter than that of a tall man. A man of six feet is not a good short-distance runner, and a man of five feet four inches may be a good short-distance runner, but cannot be first-rate at a long distance, where the length of the step is an important element in success. A man of five feet seven or eight inches can adapt himself most easily to either the one or the other, and it is from men of this height that first-rate runners are chiefly recruited, for both short and long distance running. A tall man, who can at the same time move his lower limbs quickly, will of course possess a great advantage, as he covers more space at each stride than does a shorter man; but long limbs are, as a rule, neither capable of, nor adapted to the taking of, quick steps.

The *age* at which running can be practised with impunity by a healthy man in training, is from twenty to thirty. *Boys* of ten and twelve—and *girls* also—can run, and run, and run with little breathlessness even, and no apparent fatigue. When the age of puberty is attained, and the limbs are rapidly growing, the lever action of the muscles and bones is continually being altered, and the centre of gravity varying almost from day to day. At this age training for running races is not only likely to be unsuccessful, but positively injurious to the growth of the body, and to the health in general. In boys' races, for those under fourteen years, no previous training should be inflicted. No one should train for running until he is at least eighteen; but twenty would be the safer age. Between twenty and twenty-seven is the best age for attaining speed in running. Training for running can at this age be undergone with comparative safety; the heart and vessels have not yet begun to show signs of wear and tear, and the elasticity of the blood-vessels can be relied upon to accommodate themselves to the increased circulation through them. Fat has not at that age begun to accumulate within the abdomen and thorax, so that the breathing has free play. *Between thirty and forty* a wise man will think twice before undergoing training for race running. He can run with impunity at a moderate pace, and for practice; but not in races. Older men should run on no pretence whatever. An old man running to catch his train, and falling down in a fit of apoplexy, is an every-day tale, and from what has been stated previously this is readily understood.

Training for running should be undertaken a considerable time before the competitive trial is to take place. The three weeks usually prescribed may be sufficient for one engaged in sports and out-of-door employment; but for one engaged at a sedentary employment, five weeks will not be too long. If not accustomed to much walking, or to quick walking, the first week ought to be spent in walking at least ten miles a day, increasing the pace until four miles or four and a quarter miles an hour is attained. During the first week, nothing more than a military "double" ought to be engaged in for, say, the distance of half-a-mile. The management of the breathing, the holding the upper extremities, and the method of moving the lower extremities, the fit of the shoes, the tightness and character of the clothing, the time of the day best suited for running, and the diet required, are the points to attend to at the outset of training.

To those training for running, the following are important points to attend to:—

1. If possible, practise at the same time of the day at which you know the race is to be run.

2. Ascertain the nature of the ground on which the race is to take place, whether soft, or covered with small pebbles, &c. The shoes must be adapted accordingly.

3. Measure out on the practice-ground the exact length of the race to be run.

4. Always have a friend with you, if you have not a professional trainer, to watch the time, and tell you how you hold yourself, &c.

5. Begin to practise running slowly at first, increasing the pace day by day.

6. If not accustomed to run against time, vary the step a little on successive days, and ascertain with which step most speed is attained. As a general rule, however, the step one naturally falls into is the best.

7. As to clothing, wear flannels; have nothing tight about the chest, abdomen, or extremities. Leave the lower extremities bare from a little above the knee downwards; leave the upper extremities bare from half way down the arm. See that the flannels do not pinch about the arm-pits.

8. The clothing should be fastened by a belt round the pelvis (haunch bone). The belt should be narrow as it passes along the side, but might with advantage widen out behind and in front, supporting thereby the lowest part of the abdomen and the back. The belt *must* pass *below the level* of the crest of the haunch bone, and *above* the external prominence (the trochanter) of the thigh bone. One can feel these two points on the sides of the haunch bone; but if the trainer is in doubt as to where the point indicated is, ask a doctor, as the question is of primary importance.

9. The upper part of body and head are to be thrown back, the chest being the most anterior part of the body. The hands should be clenched, the elbows bent, and the upper extremities held firmly up with the fists close to the front of the shoulders. Do not over-do any of these positions. The object of tucking

the arms up as directed, and raising the shoulders, is to take the weight off the chest, thus allowing of freer play for the breathing.

10. Learn to breathe regularly and freely; if the breath be held for a time, let it be only during a spurt at the end. Commence deep and free breathing from the first, and do not wait until breathlessness comes on.

11. The shoes must have very low heels, or be without heels altogether. The "upper" may be of canvas, the "sole" of thin well-tanned leather. No lace should be used; it is always liable to break or get loose; in place of the lace a piece of broad elastic sewn firmly in, where the shoe is cleft for the lace, is by far the safest and most comfortable means of fixing the shoe.

12. In regard to diet, consult the rules laid down for moderate diet in the previous pages.

JUMPING.

Jumping consists in taking a sudden bound or jerk from the ground with both feet at once. The lower extremities are first bent, the foot upon the leg, the leg upon the thigh, and the thigh upon the abdomen. One crouches down, as it were, before making a leap, just as does a leopard, tiger, or a cat. It is the sudden contraction of the muscles of the front of the thigh and the back of the leg, that causes respectively the straightening of the knee, and the sudden push-off from the ground necessary to raising the body. The body is then thrown forward, or upwards, or both forwards and upwards, for a distance dependent on the strength of the muscles, and the formation of the body. For very high and very long jumping a man must be tall. In the length of the muscular sweep and the longer lever action of his lower limbs, a man of from 5 feet 10 inches to 6 feet has an enormous advantage over a man of 5 feet 4 inches. A man cannot jump much more than his own height, whatever that may be.

A short man may excel a tall man in a standing high jump and a standing long jump. In these cases it is the suddenness of the contraction that tells, and the shorter muscle has the advantage over the longer muscles of a tall man's limb.

The age at which perfection in jumping may best be attained is from some time after full height is reached, say eighteen or nineteen, until the twenty-fifth year.

The rules laid down for running may be followed for jumping, modified according to the circumstances of the sport.

Many athletes at the time of jumping chew some stick, india-rubber, or toothpick, biting it firmly between the teeth at the time of the supreme effort. Others take a small piece of stick and clench it firmly in the hand; such men declare they could not jump well without this contrivance, and the fact may be worthy of attention, but it is too long for discussion here. The enormous energy expended in jumping, and the suddenness of the act, is a great strain on the muscles and tendons, and on the heart and blood. Taking the average weight of a man as 11 stones, *i.e.*, 154 lbs., the force expended in jumping the height of 1 foot is equivalent to a force capable of suddenly raising 154 lbs. 1 foot off the ground. Supposing a jump of—

2 feet high to be made, it is equal to the expenditure of a force of 308 lbs.
3 „ „ „ „ 462 lbs.
4 „ „ „ „ 616 lbs.
5 „ „ „ „ 770 lbs.
6 „ „ „ „ 924 lbs.

The highest jump on record is 6 feet 2½ inches. The force necessary for such an act is equivalent to the sudden raising of 956 lbs., or about two-fiths of a ton, and hurling it in the air, and the main part of the force is produced by a few of the muscles of the calf of the leg and the front of the thigh.

The dangers arising from jumping are :—(1) The sprain of a joint, especially the ankle (see page 451). (2) The fracture of the small outside bone of the leg (the fibula), about four inches above the ankle, known as Pott's fracture (see page 451). (3) Rupture (hernia), that is, the sudden protrusion of some of the abdominal contents, usually the intestines, in the region of the groin. (4) Fracture of the kneecap (patella). This arises in this fashion : the kneecap is placed in front of the knee, and is the spot on which the strain of the muscles in front of the thigh is thrown. The sudden contraction of the muscles catch the bone as it lies across the lower end of the thigh bone, and it is snapped across the end of the thigh bone as one would break a stick across one's thigh. The individual to whom the accident occurs falls down. It is not the fall that occasioned the break, but the break that caused the fall. Not infrequently, when one kneecap is broken, the attempt made to prevent falling throws so great a strain on the other knee, that both kneecaps are broken.

For the means of assisting the injured see page 451.

Dancing.

In all times and amongst all peoples, civilised and savage, dancing to music has taken a prominent place in the history of their sports and pastimes. Like many other ancient customs which civilisation has changed and doctored to suit altered times and manners, dancing is so docked of its original habiliments, that it seems impossible to associate under the same name the method and object of dancing amongst the ancients, with the modern ballet girl, or with the typical after-supper dance, in a small, over-crowded drawing-room. What a distance dancing has travelled from the time when it was performed to the clash of cymbals and the clang of trumpets, in honour of some god, or king, or conqueror, to the modern private-party dance, in honour of nobody, and generally undertaken with worry and bother to the host and guests !

In ancient days it was performed out of doors, but in modern days it is conducted in badly-ventilated rooms, loaded with excess of carbonic acid gas, reeking of trashy perfumes, and hot with the refuse products of coal gas. What a contemplation this is to the thoughtful ; what a parody on nature and nature's gifts to man ! Society, however, demands it, and the world succumbs to the thraldom.

Amongst many peoples, especially the Asiatic and African, dancing is indulged in with method and object. The dance is an unwritten history of some love scene, some heroic deed, some historical fact, &c.; it is nearer our modern opera than anything else, as the performers at the same time join in singing, adding thereby explanation to their otherwise dumb show. A dancing troupe from the island of Java have given a performance in London which was interesting in the extreme, and their programme included such dances as "The Rising of the Waters," "The Tempest," "The Saving the Princess," and so on, each dance being a descriptive tale and the details explained by recitative. But is any such notion present in a modern quadrille? Let us see. Analyse the different figures, as they are called, and think for a moment of their meaning.

In the *first figure* opposite couples cross over and return to their places; the ladies then engage in what is called ladies-chain, and setting to partners ends it. Here the idea evidently is a friendly advance on the part of the ladies towards better acquaintance.

In the *second figure* the opposite couples advance and retire together, and after setting to partners, advance in the same manner. Here is evidently a further step, as both couples act in harmony.

In the *third figure* acquaintance has so far advanced that the four join hands and form a line.

In the *fourth figure* the gentleman has come to know his *vis-a-vis* so well that he entrusts his lady partner to him, who, returning the compliment, entrusts his lady partner to his *vis-a-vis.*

In the *fifth figure* all the couples in the set of the quadrille have improved in acquaintance, so that they all join hands, and advance in good friendship together.

In the *sixth figure*, often called the flirtation figure, every gentleman so trusts his neighbour that he allows his lady partner to dance, or as the name implies, flirt with every gentleman engaged in the quadrille.

It is evident, then, that the quadrille is a "growth in intimacy" between the different couples engaged in its performance. The "Lancers" bear a like explanation, and so do most country dances.

The *effects* of dancing vary according to the manner in which it is engaged in. The acrobatic performance called dancing, seen in the stage ballet, requires an amount of care in training and education that lasts over many years. The acme of perfection is considered to be the power of walking on the points of the toes. This necessitates an amount of extension of the foot that can only be attained by the foot of a young person; hence, practice must be commenced at a girlish age. The consequence of such a position of the foot causes the muscles of the calf of the leg, and the extensors in front of the thigh, to assume enormous proportions. The foot comes to be flat, and when the dancer is walking ordinarily the gait is ungainly. The muscular development of a professional dancer from the middle of the body downwards is, in many cases, extraordinary.

The effects of ordinary dancing would be no doubt beneficial were it not for the unhealthy surroundings. The amount of exercise obtained by a long waltz no doubt does many a fashionable woman a great service. Walking is never dreamt of, and a good dance causes her to breathe more deeply, assists the action of the liver, and causes the blood to circulate more freely through the vessels. Were it not for the length of time that it is kept up, and the evil effects already mentioned, dancing would be an excellent means of causing the lazy to take exercise and the dyspeptic to be relieved.

In a crowded room it used to be fashionable for ladies to faint, but as tight-lacing went out so the fainting fashion went out. Still do we find fainting common, and when it does arise, let the following steps be taken. (1) Lay down the person who has fainted quite *flat* on the ground, and, if fussy people will raise something, let them raise the feet, but not the head. (2) Undo tight clothing everywhere. (3) Keep the bystanders as far off as possible. (4) Get a draught of cold air to play on the face. Other steps, such as dashing cold water, applying smelling salts, &c., may be added to the above with some possible advantage.

After coming home from a dance, if one wants a real luxury, obtain, if one can, a warm plunge bath. This is pleasant in the extreme: it frees the skin from perspiration, and prevents aches and muscular pains next morning.

RIDING.

The privilege of exercise on horseback belongs, in towns at least, to persons of the richer classes. In the country, every farmer has a pony on which to mount when occasion arises, and frequently taxes his income by keeping a hunter in addition, with which, in fox-hunting counties, he may follow the hounds. To women, also, riding affords excellent exercise, but it is, unfortunately, only women of the richer classes who can obtain it. In the case of the fashionable classes in towns, especially those engaging in London season life, the daily parade in the "Row" is, even in its mild way, an immense advantage to both men and women, but more especially to the latter.

The time of life at which riding exercise can be taken with advantage comprises the entire period from childhood to old age. When old age is attained, hard riding, such as one is led into whilst following hounds, should not be thought of. A man who is getting on in years continues to have "last turns," until he comes to grief over some fence or ditch, and innumerable are the evil consequences that may result from an old person falling from a horse. The great use of riding to the young is not so much the exercise itself, as that could be obtained as well by other means, but it teaches familiarity with the saddle at an early age; it tends to the formation of a fearless and bold character in early life; and it teaches a regard for the most noble of the lower animals, attainable only by knowing an animal at close quarters, as it were.

To men from thirty-five to sixty-five years of age riding exercise is an immense advantage. The very possession of a horse almost compels a man to go out, if for no other purpose than to give the horse a turn, and exercise is thereby taken which would otherwise have been neglected. In the next place, the rider is carried into the open air, and, if he be a wise man, into the country as often as possible. The motion of the rider is such that the amount of exertion suitable to the inclination and the strength can be obtained at will. Many and many a man will go for "a ride" who could not be brought to go for "a walk;" it is more attractive than walking in many ways. In the first place, riding is a change; one is always walking, and to walk is no change in the means of progression. In the second place, the very fact of moving at a rapid rate is a nervine tonic of itself, and induces an inclination to go on. The distance possible to be accomplished; the possibility of getting out of streets and roads that from long familiarity possess no interest; the possibility of the townsman getting into the country sooner; the good spirits engendered, and the feeling that the ride is bringing, not only temporary pleasure, but also a stock of health—all add to the pleasure of riding and the likelihood of its being continued when once begun. It is for middle-aged men, engaged in sedentary pursuits, the most suitable of all means of exercise next to walking, and, over and beyond that, it presents many attractions for the reasons above mentioned.

For "delicate" women, and for men suffering from the evil effects of sedentary lives, good living, and other innumerable causes of congestion of the abdominal viscera, horseback exercise is by far the most suitable of all forms; and, when we come to inquire after what manner riding affects the body, we find that it is a kind of mixed exercise, partly active and partly passive, the lower parts of the body being in some measure employed, while the upper parts in easy cantering are almost wholly relaxed; in fact, when one is at ease in the saddle, is sure of one's horse, and rides loose, there is little action on the rider's part, so that one may be said to be exercised rather than to exercise oneself. This is widely different from almost all other forms of exercise, such as walking, running, and rowing, in which much muscular exertion is necessary. More especially is riding essential to dyspeptics who lead sedentary lives (and how few townsfolk elude the troubles of dyspepsia), from the action that it has directly upon the abdominal viscera. It is very plain that the contents of the abdomen must be stimulated in their action by the continued agitation and infinite succussions coming close one after the other consequent on the motion in riding.

There is another property of riding—that it always gives a freshness to the countenance of those who indulge in it, which lasts for some time, and by and by will become permanent; add to all this the vivacity and gaiety which always result from brisk motion, and we come to the conclusion that no one can be an enemy to riding exercise but one who is ignorant of its attractions. The generality of men are, however, by their employments and affairs, kept so much from the practice of it, that they, for the most part, judge of it by what they themselves have experienced on a journey where an indifferent horse, bad roads, and other inconveniences have made their ride rather a toil than a pleasure. It must, like other pleasures, be pleasant to be of use for health purposes, and enjoyment can be obtained by attending to common-sense *dicta* in regard to the matter. The pleasure, as well as the benefit, likely to ensue must be attended to. As to delicate people, and those suffering from long-standing abdominal ailments, it must be slow and gentle means that can act to any purpose, and the taking pleasure in the means of regaining health must greatly contribute to the relief those means are intended to give.

While thus upholding the benefits, it would be unwise to omit the evils which might *possibly* result from the injudicious use of riding. In the first place, placing boys on thick, round-set ponies, as fat as butter balls and as broad as billiard tables, causes the lower extremities to be distorted, and may induce "bow legs" and other distortions, which may lead to permanent disfigurement. It is but common sense that such a condition should arise, and it is but common sense that a boy should be suited with a horse, as he is with his clothing and with his food. Amongst men, the effects of much riding become pronounced in some way or other. Tall men—*i.e.*, men of 5 feet 10 inches and upwards—almost, invariably become "knock-kneed;" on the other hand, short men—*i.e.*, men of 5 feet 6 inches and under—almost invariably become "bow-legged." The men who show least deformity are those of a medium height, of about 5 feet 8 inches. The facts are readily understood after the least reflection on the matter. The differences in height between men are almost wholly dependent on the length of the lower limbs; if, then, two men of different heights are placed on horses of the same build, one of the men will find that his horse suits him, whilst the other will be less comfortable on his. In time, of course, it would be found that both might be comfortable on similar horses, but it would be at the expense of a change in shape in the lower limbs of one or other of them, as above indicated. The position of the thighs and feet taught by riding-masters brings it about that the thighs must be held fairly firmly against the horse's sides, and the legs allowed to drop straight from the knee, with the toes turned straight forward. This is an awkward position to those who have not practised it, and one requires acquaintance for some considerable time with the saddle before one is quite comfortable in it. The explanation of the changes in the shape of the limbs is readily understood from a consideration of the position of the limb. Amongst the changes a wasting of the muscles on the inside of the thighs is to be observed. These groups are the means by which the thighs are held lightly against the horse's sides—the "adductor" groups they are called. They first become enlarged, and then, from over use and pressure combined, they undergo wasting (atrophy). The shambling gait of ostlers and stablemen, with their spindle-shanks, big feet, and distorted limbs, are to be accounted for by the semi-equestrian life they lead—now in the saddle across a hunter or a child's pony, now working in the stable in every variety of position.

Another bodily impression caused by riding is seen in those who place their feet well "home" in the stirrup, as most fox-hunting men do. The consequence is the top of the stirrup catches the lower end of the shin-bone (the tibia), and from the continual friction of the part, consequent on constant riding, the bone becomes thickened at the spot indicated. This is developed so gradually that little or no inconvenience results therefrom, but it is a fact that surgeons ought to remember in dealing with the frequent injuries to the ankles of fox-hunting men.

Owing to the fact of the left arm being employed in holding the reins, and to the right arm being allowed to hang loosely, much riding in time causes a marked change in the shoulders. The left shoulder becomes slightly higher than the other. Especially is this the case with girls and women, with whom it brings about a "growing out of the shoulder"—*i.e.*, a prominence of one or other shoulder, dependent on curvature of the spine towards one side.

Again, from the position of the fingers in holding the reins and the whip, there is apt to ensue a contraction of the fingers, especially in rheumatic and gouty people.

The left arm, also, from being advanced and exposed to wet and cold, consequent on its position in holding the reins, is apt to become rheumatic, and to give rise to trouble. This must be prevented by extra coverings for the exposed part.

The last two dangers are also apt to ensue in the case of those engaged in driving.

It is impossible to do more than mention a few of the numerous hunting-field accidents. Broken collar-bone (clavicle) is one of the most frequent; dislocation or fracture of a finger, from catching it against the pommel of the saddle whilst pulling up a horse from a stumble; sprained ankle, knee, hip, wrist, elbow, or shoulder, any of which may result from a fall from a horse. A long list of other accidents might be enumerated, varying from the most trivial wounds to a broken neck. For the means of rendering first aid in the hunting field see the simple directions given in a later section of this article devoted to Football.

The opponents of healthy sports and exercises may perhaps raise a hue-and-cry when they see such a list of accidents as have just been set forth, but to them let Mark Twain's famous discovery apply—viz., that, as in railway travelling, so on horseback fewer people die than in bed; hence, if one wants to live long, let him be on horseback rather than in bed.

SKATING.

Closely allied to walking in the mode of progression is skating. It is simply an exaggerated swinging walk, with this difference, that the foot on which one rests is not stationary, but moves along at a rapid rate. Both feet are never off the ice at once, but, as in walking, the feet are alternately used for support, and as propellers. The difficulty felt on first starting to skate is soon overcome, and the rapid motion is an intense pleasure, while at the same time it brings freshness to the countenance and gives exercise to the limbs. Skating can only be obtained in climates where the winters are sufficiently severe; and in countries such as Canada, where active out-of-door exercise is unattainable for five months in the year by any such means as walking, riding, rowing, &c., skating is an inestimable boon to the health of the community. What can compare with skating in wintry weather as a means of obtaining pleasure, exercise, and health? It is in winter, to a man leading a sedentary life, what walking and horse exercise are to him in summer. When frost confines the horse to the stable, or the daily straw-parade, let the disappointed rider walk a mile or two to see the skaters, or, better still, let him join in the sport. To women, more than to men, is skating a great boon. Men must go out in all weathers to attend to business, &c.; but women, who have no need to go out, will remain indoors as long as the cold weather lasts. The prospects of a day on the ice will, however, induce all but the most coddling of girls, or the most timid of "delicate" ladies. Were it not for some such device, Canadian, Russian, and Swedish women would in winter hybernate like the bear, and reach premature old age. Many are the instances of man's adapting himself to circumstances; and skating of all others is, perhaps, the most clever.

The good to the circulation, respiration, and digestion is even greater than in walking, and as the mode of progression is novel, and the rate of progression greater, it is much more attractive.

The dangers from skating are—

1. The giving way of the ice—a subject into the discussion of which it is unnecessary to enter. Let common sense guide each one in regard to the safety and danger of the frozen pond or river.

2. Catching cold from getting over-heated in cold weather. Common sense must again teach people that, when they commence to skate, outer-wraps must be laid aside, and again put on when skating is finished.

3. Sprains, especially of the ankle, and other minor accidents arising from falls.

Ankle-boots with strong uppers must be worn during skating. Those who have "weak" ankles ought to wear skates with ankle-straps and buckles; acme skates being delegated to those who are not afraid of "going over their foot." Common-sense dicta will, however, obviate all the probable dangers of skating, which is the most health-giving, the most cheering, and the most graceful of our winter amusements.

Rowing.

The means of obtaining exercise by rowing is so largely indulged in, by those more especially who live near large rivers in England, that it has come to be not only a regular pastime and athletic exercise, but a means whereby the physique of the nation at large is directly affected. The crowds who flock to the Thames, the Severn, the Mersey, the Tyne, and hundreds of other rivers, for the purposes of enjoyment or of perfecting their skill in rowing, pronounce it to be a popular sport and a pleasant means of recreation. In all parts of the world where a sea-board or a large river exists rowing is used as a means of progression, but in England and in English-speaking countries alone has it come to be considered as a sport and pastime of national importance to the health, physique, and character of the people. What the youths of other nations seek in the gymnasium, the youths of this country find in rowing, cricket, football, and dozens of other games. In other and poorer countries the whole energy is spent in trying to earn a livelihood, but the wealth of thousands of families in this country precludes the necessity of work, and much of the surplus energy is spent by them in some of the many forms of manly sports so happily adapted to the perfecting of the race. Thus is maintained that tone of body and mind which has made Englishmen, and the well-to-do in particular, first in the scroll of fame as soldiers, sailors, explorers, athletes, &c., and has had much to do with engendering that healthy spirit of uprightness and that sense of honour which, inculcated in the boy at a public school, find expression in the daily life of the man. The richer classes of a nation have much to do with the guidance of the people towards good or evil, and so long as the rich classes of this country take part in, or patronise, healthy sports and pastimes, instead of setting the example of effeminate sloth, so long will they remain a blessing to the community, and be the means of stamping a manly, vigorous, and healthy tone on the nation itself. We have to congratulate ourselves that such is the case at the present time, and as long as this tone continues there is no fear of the fulfilment of the predictions of the downfall of the English nation, so frequently expressed by would-be prophets.

The frequenters of the Thames and other English rivers can become familiar with the rowing-boats and the means of rowing adopted by almost all peoples. From the Indian canoe to the eight-oared racing boat; from the Norwegian skiff to the Venetian gondola, or the broad-beamed punt—all are to be found there, propelled by the means peculiar to each. All sorts of adaptations for rowing are found, from the wooden rowlock pins of a lumbering tub of a boat to the light metal framework of the outrigger; all sorts of shapes of boats are found, from the needle-pointed racing boat to the broad punt.

After these general statements we must now discuss rowing as it affects individuals, and in the discussion it will be necessary at the outset to distinguish between hap-hazard occasional rowing, and the training for racing. With those who engage in occasional rowing exercise it is of the first importance to deal, as they represent the largest section of the rowing community, and because they are very apt to suffer from ill-adjudged efforts in pulling, &c. To this class belong those who take their families for, say, a month to live in a house on the river; those who go for a five or six days' pull; and those who go for a day now and again. A house or lodging by the river is a very pleasant place of resort, pretty to look at and convenient for the purposes of getting to work; but it frequently has a great many drawbacks. In the first place, it is by the riverside, and therefore liable to be enveloped in the moisture which invariably rises from a river, especially in hot weather. Late summer and autumn are the most dangerous seasons in this respect, spring and early summer being the least subject to bad effects from the evening dew and damp. It is better to have, if one is to live for some time, say a month or two, by the river, a house or lodging at some little distance from, and considerably above the level of the river. It cannot be good for children who leave London for change of air to live for two or three of the hottest summer months actually on the river. It is the very opposite of bracing, and though delightful, and attended by the best results for a period of a week or two, it is not calculated to do good for a longer stay. By others who remain for a few days the usual warnings with regard to damp beds, &c., have to be attended to in riverside, as in all other hostelries.

The dress to be worn whilst rowing must be of flannel, if health and comfort are an object; if one is on the river most of the day, the same clothes ought not to be worn two days following; after rowing the clothes should be turned inside out, and hung in the dressing-room, if there is one available, or in the open air. There should always be in the boat a large wrap, ulster, or plaid, to use when one stops rowing.

For an occasional pull it may not be possible to have the regular rowing kit recommended, but whatever one wears must be loose, so as to give free play to the limbs. A belt just above the hips, or, what is better, a strap in the trousers, or trousers tightly fitting round the hips, should be the only tight thing allowed. The compression, whatever it is, must be below the crest of the haunch-bone (pelvis). For women the clothing should be loose everywhere, stays ought to be left off, and flannels, not chamois leather, ought to be worn next the skin.

When one unaccustomed to pulling an oar begins to row, he holds his breath at each stroke, pulls with his arms, and gets up so rapid a stroke that in a few minutes he becomes breathless and is forced to stop. Not only is this uncomfortable, but it is dangerous. In the case of both young and old it may give rise to an abdominal rupture (hernia), dilatation of the cavities of the heart, rupture of a heart-valve, varicose veins, &c. In the middle-aged it may set up, in addition, the disease called aneurism—*i.e.*, a dilatation of the walls of a main artery; or rupture of the heart substance or of an artery in the brain may ensue.

Let the uninitiated take warning in time, and let those accustomed only to occasional rowing exercise attend to the following points:—

1. Never row immediately after a full meal.

2. Stop when fatigue comes on.

3. Allow the breath to *escape whilst the oar is in the water.* This is the great secret by which to avoid the evil effects of strain during rowing. Instead of fixing the diaphragm and holding the breath during the time of pulling, do exactly the opposite; let the diaphragm go loose, and allow the breath to escape. In this way the strain on the heart and vessels is prevented, and the abdominal contents are allowed plenty of room. Breathlessness also is avoided, and the power of continuance is obtained.

4. Never allow yourself to be dragged into racing another boat, whether by "chaff," or by the spirit of emulation inherent in all of us. Those unaccustomed to rowing are generally those who are ready to indulge in spurts and races with other boats.

5. Get into a slow stroke, about 24 to the minute—at any rate, to begin with; it is never advisable, unless in training, to row more than 30 strokes a minute.

6. If one is to have luncheon in the middle of a day's rowing, attend to the following:—Put on extra wraps when the boat is pulled up. Spend a quarter of an hour in washing, &c., before commencing to eat. Eat in moderation whatever one likes, only not too much of anything, particularly new bread and pastry. Drink water or soda-water, or claret and soda-water, or one glass of ale; beware of the temptation of continual "nips" of brandy and sherry, and the still greater temptation one is led into to indulge freely in beer or "shandy-gaff" (*i.e.*, ginger-beer and beer), especially if it be intended to row some distance after luncheon. Smoke a pipe or cigar after luncheon if smoking is a habit. Never smoke whilst pulling.

7. Have a cup or two of tea at tea-time. Especially is tea pleasant at the end of a long day's pull.

8. Change the clothing from the skin outwards immediately the day's work is finished.

9. Before going to bed have a warm bath, temperature 92° Fahr. This is a specific against the aches and muscular stiffness which annoy one the day following a long pull on the river.

Blisters on the hands are very annoying, and may necessitate stopping rowing altogether, so that many a promised week's enjoyment may be cut short the first day. To prevent blisters:—

1. Keep the hands dry by wiping the sweat from off them frequently with a handkerchief slightly dusted with violet powder, French chalk, or, what is better, oxide of zinc powder.
2. Keep the handle of the oar dry.
3. See that the handle is quite smooth.
4. Never let the oar move within the grasp of the hand. All "feathering" must be done from the wrist and slightly from the elbow. Should a blister "threaten," stop rowing for an hour, wash the hands well with soap and water, wipe the tender parts over with some vinegar, and then gently rub spirits of wine, or if that is not available, whisky, gin, or brandy over the tender parts, drying the part perfectly between each step of the process. In the event of a blister actually having formed, rowing ought to be stopped, but if that is not possible, dust some flour, oxide of zinc, or violet powder over the handle of the oar and the hand, grasp the oar tightly, and if possible change the oar or sculls. If at the end of a day's pull blisters are found on the hands, leave them alone if the skin over them is very thick, and apply a spirit lotion as above, after careful washing with soap and water. Keep the hand cool whilst the lotion is on the hand, to allow of its evaporation, and to prevent its acting like a poultice. Should the blister formed have a thin cuticle over it, prick it, and let the fluid escape; avoid squeezing it, and dust oxide of zinc powder over it. In the event of the skin being actually removed, dust the surface of the raw skin with oxide of zinc powder or fuller's-earth.

The benefits to the health resulting from rowing exercise are many :–

It is a change in the mode of progression from the ordinary method—walking—hence it is novel, pleasant and engenders a desire to go on simply from the fact of its being a change. The muscles employed are many of them not used in walking, and those employed in both are, in rowing, used in a different fashion. The force by which the boat is propelled is by the lever-like action of the oar, the fulcrum is at the rowlock, the power is at the handle, and the weight is the resistance offered by the water : this is a lever of the first kind. The power is, of course, the muscular force of the individual handling the oar; this is, again, a lever-like motion of the body, the fulcrum being at the seat and feet, the power at the body, and the weight at the handle of the oar, furnished by the resistance offered by the water. The muscles employed in pulling may be summed up under two heads—those that are employed in the forward swing, and those employed in swinging backwards. In the *forward* swing all the joints of the lower extremity, the hip, knee, and ankle, are flexed—*i.e.*, bent; of the joints of the upper extremity, the shoulder is flexed—*i.e.*, brought forward ; the elbow is extended—*i.e.*, straightened; and the wrist is first extended and then flexed in feathering the oar. The body is bent forwards by the muscles in front of the abdomen and spinal column. In the *backward* movement the reverse takes place: in the lower extremity, the hip, knee, and ankle are extended—*i.e.*, straightened; of the joints of the upper extremity the shoulder is extended—*i.e.*, pulled back; the elbow is flexed—*i.e.*, bent; and the wrist is held straight. The body is bent backwards by the muscles at the lower part of the back, and by those of the spine in general. It is needless to name the muscles employed in these acts, but it will be seen that the enormous number of joints put into use, and the varying position of the muscles, calls into play nearly every muscle of the limbs and trunk. It is during the backward pull that the great force is expended, and it would naturally occur to one that the muscles employed during the forward swing, not having a tithe of the work to do, would not be proportionately exercised. This is, however, not the case; no group of muscles can act powerfully without the opposing group give a *point de resistance*, a *point d'appui* from which to pull.

For instance, let the reader put the elbow on the table, and allow the hand to drop forward with the palm downwards; that is to say, relax the extensor group. Now try to clench the fist with the hand in this drooping position, and it will be found that the fingers are bent feebly, but the fist cannot be clenched. Or, again, let the reader fold up the sleeve, and clench a stick firmly in the hand; it will be found that the muscles both on the front and the back of the forearm are rigid. Look at a blacksmith's forearm; it is the muscles on the back that are noticed to be hard like cords when he is at work, and these are the extensors, offering only a point of resistance for the flexor muscles in front of the forearm, employed in causing the fingers to hold the hammer. So with rowing; it employs the flexors and extensors equally, and thus supplies abundant exercise to almost the whole body. There is no doubt that the upper part of the body and the muscles of the spinal column are more strongly employed than are those of the lower extremity, although the sliding seat does give more work to the lower limbs; hence the necessity of rowing men taking walking exercise to bring the extremities up to proportionate strength.

There is no doubt that rowing gives more work to the muscles of the back than any other kind of exercise. This is of the first importance to both men and women, but especially to women. The chief work of the muscles of the back is to support the body in the erect position, and the better they are developed the better will the carriage be, and the less likelihood of stooping shoulders, contracted chests, and the like. Now, the work of the muscles in supporting the body is largely relegated in women to the stays, and in consequence the muscles undergo wasting and fatty degeneration, in fact, atrophy; and when the stays are left off, the muscles are unfit to support the body. Rowing, however, exercises the muscles condemned to waste, and imparts a natural carriage to the girl's frame, and not one bolstered up by whalebones, steel bands, and firmly-corded rods. To women, however, rowing is extremely dangerous, from the fact that they do wear these tight garments, which they refuse to lay aside, even to gain health and strength during a row on the river, or a ride on horseback. Let those in charge of girls understand how important it is to give strength to the back if one wishes to bestow a graceful and upright natural carriage; and when such is understood, the importance of laying aside artificial support during active exercise will be followed, and the attempt to give strength to the back by lying down flat on a bed or hearthrug for an hour or so a day, as is done in hundreds of schools, will be changed for an hour's walk, a game at fives or lawn tennis, without stays or any artificial props. It is too long a subject to go into to point out all the dangers that come to women from wearing tight clothing during exercise; but what was said early in this article must be again applied here and acted upon. Country women, working in the field, hang their clothing from the top of the haunch bones; but when women are town-bred they change the place of fixity, bringing it up to the lower ribs. Here is perpetually a tight girdle round the body directly over the stomach, liver, spleen, and the lower part of the chest-wall. It is wonderful how nature provides for this change of things, and how women retain their health at all. It is useless preaching against dress of this kind, unless one has something else to suggest that will be equally attractive; and as the first step in that direction is to change men's tastes, and try to persuade them that the waspish waist is not beautiful, it is little good lecturing women on the subject. However, it is surely possible to persuade them that if they want to avoid danger, and to earn natural grace, they must lay aside tight clothing when *engaged in active exercise.*

What is the amount of muscular expenditure incurred by rowing? It is, on the authority of Mr. MacLaren, of Oxford, said to be as follows :—

Rowing one mile at racing speed = 18·56 foot tons. Now, walking a mile at an ordinary pace causes an expenditure of 17·67 foot tons; hence there is but little more muscular force spent in rowing than in walking a mile. It is, however, on account of the quick stroke, the respiratory organs that are taxed in rowing a race, and not so much the muscular force; hence the amount of energy expended must not be taken as altogether indicative of the strain on the body. Thus the muscular expenditure on a six-mile row at racing speed is only 111·36 foot-tons, or about a third of the amount of muscular expenditure considered necessary for a healthy man indulging in active exercise. Frequently, however, those going for a day on the river row, say eighteen miles, and in that case they would expend about 300 foot-tons of energy. The current, the weight of the boat, the number of occupants, the number rowing, the distance travelled, and many other items so complicate the calculations that it is impossible to give definite statements how far one ought to row. Ten to fifteen miles, at a rate of not more than four miles an hour, with frequent stoppages, is not too much for two ordinary oarsmen out for an occasional trip, with a moderate boat load and against a medium current.

In regard to the training for rowing races, the reader must carefully consider the section on Food, and the dietaries there recommended. It was with rowing in view that these tables were put together, so that it would be simply a reprint of these were they to be again mentioned here. The apportioning the hours of the day as regards ordinary day work and exercise was there fully discussed (pages 415, 416).

Many articles have been written and many inky wars have been waged in the combat as to whether training for rowing was good or bad, whether the health of the men who had gone through it suffered in consequence, and whether the intellectual capabilities of those Oxford or Cambridge graduates who trained hard for 'Varsity races, was of a high or low standard. So far the evidence obtained is not of much value one way or the other, as the fact of rowing a 'Varsity race does not imply a strong muscular man. He must weigh eleven or twelve stone, and must have extraordinary respiratory powers to stand the fearful rate of 36 to 40 strokes a minute over a distance of three or four miles. The muscular energy expended is not more than 60 foot tons, but the rate of breathing is increased to 36 or 40 a minute, and the pulse to 110 or 120. What is the meaning of this fearfully quick stroke? It is this: the boats in which races are rowed are so light and so shallow that no "way" can be got on them. At the moment of the stroke the boat is urged through the water like an arrow, but the moment the stroke is finished the boat well-nigh stops. This fact can be proven when a racing-boat attempts to shoot a bridge with a heavy current running beneath it. A four-oared outrigger will fail to shoot what two boys in a tub of a boat go through easily. The heavier boat gets "way" upon it, which the shallow, narrow, needle-like structure, called a racing-boat, cannot. Hence the necessity for rapid strokes, as motion of the boat forward is well-nigh confined to the time when the blade of the oar is in the water. A very quick stroke on an ordinary boat is actual loss of power and waste of energy, as a stroke of 25, well maintained, will yield very nearly the maximum speed possible with such craft.

In training for rowing, then, the respiratory powers must be looked after. Mr. MacLaren tells us that men actually lose stamina during exclusive training, and that at race time they cannot be considered muscularly strong. Training for rowing consists in so arranging the exercise and diet, etc., that the thoracic and abdominal viscera allow room for extraordinary breathing. The meat diet—*i.e.*, the nitrogenous diet so much in vogue at the present day in training—prepares the oarsman, not by increasing muscular strength, but by increasing the breathing power.

The dangers from training for racing, and from racing itself, are similar to many of those already mentioned:—1. Rupture (hernia); 2. Dilatation of the heart; 3. Piles (hæmorrhoids); 4. Varicose veins in the legs 5. Dilatation of the air vesicles of the lung (emphysema, or asthma, as it is popularly called); 6. Dilatation of an artery from too much work thrown on it (causing aneurism); 7. Rupture of a valve in the heart; 8. Training off. The last is the only one not discussed before. It is the physical condition induced from the regimen consequent on training. This state is indicated by a loss of weight, loss of spirits, loss of stamina, and loss of breathing power. The work is done without energy, food has no attraction, and it is taken only as a matter of duty. The nights are not good, dozing and frequent wakings and dreams taking the place of sound sleep, so that the man's digestive, circulatory, and respiratory powers are completely out of gear. This may be caused by over-feeding, want of sufficient exercise (as rowing is not enough), attempting too much mental and bodily work together; or it may be a typhoid or agueish state induced from frequenting the banks of a river into which town sewage is emptied. Such a man should at once be examined by a medical man, for the purpose of ascertaining whether his trouble is transient or permanent, whether it is organic or accidental and of little importance. Steps will then be taken accordingly. If the trouble be a passing one, rest and care for a day or two will put things to rights; this is best done by allowing the man to do what he likes for 36 hours: he may eat what he likes, drink in moderation what he likes, and if he wants a pipe let him have it. If the trouble be serious he ought to be prevented training for racing, or stop rowing altogether.

CRICKET.

Of all our national sports cricket is the chief. The days spent in the cricket-field are the boy's delight, and the man's most pleasant reminiscence. Cricket is English, purely English, and it follows the children of England to the Australian colonies and the American continent, to the empire of India and the South African settlements; in a word, it is the companion, the health-giver, and the manly maker of almost a nation and people. The evolution of cricket was a good thing for this country; without it the summer months would have presented but few out-of-door sports, and the afternoons of school days would have been devoted to pastimes less likely to engender a good spirit, such as bird's-nesting, fishing in forbidden waters, lounging, learning to smoke at an early age, fighting, and all kinds of mischief. The spirit of honour, self-reliance, and sound emulation cricket almost creates in boys is productive of much good, both as to the physical health it bestows, and the pleasant way it ingrains, at an early age, into the character, all that is best in us. The boy finds his level amongst his companions, and is estimated by his smartness, steadiness and physique; his early school-day triumphs, when he "took more than half the wickets," when he almost "licked off his own bat" the club of some neighbouring village, are impressions which last, and memories which yield pleasure when the greatest successes of manhood are forgotten. Cricket is the first game in which the boy indulges which widens his notions of things, and tells him there are communities beyond the one in which he moves. The English country boy of seven knows the neighbouring clubs, knows that far away, at a great elevation, there are Graces, Lyttletons, and Studds; the bigger boys get newspapers in which he reads of enormous scores, and wonderful bowling and marvellous fielding. He from that moment feels he belongs to a community wide-spread and huge, and the feeling gradually grows upon him, until by the time he is twelve he knows the names and many of the doings of the first cricketers in the country. If for nothing else, cricket is a blessing in this one particular only, seeing that no other game in which a young boy can join will do so much to extend his knowledge and widen his views, in fact, give that training which is alone obtainable by knowing that although but a drop in the ocean of life, and but a cypher in creation, he may, if he have ambition and aptitude, see how it is possible to climb the ladder of fame by dint of perseverance, not only in cricket, but afterwards in the matter of his life-work. The early age at which cricket can be indulged in is a great point in its favour. A boy playing cricket with those of about his own size and years is almost free from danger, but should he join in the game with lads or men he may get hurt by a fast ball, or one sharply hit. For youths at school, cricket is the perfection of games, as it requires no such special preparation as do rowing, running, and such like. A youth of fifteen has no fat in his abdomen to impede his breathing, and an hour or two after his mid-day meal he can run without becoming breathless. It is only when the age of about four-and-twenty is reached that one feels encumbered and out of breath by suddenly starting to play cricket. Hence cricket requires one who has reached the age of manhood to be in fair training to be successful. The training required, however, is not severe, and chiefly consists in walking exercise, say eight miles a day, and a turn with dumb-bells of moderate size, or, what is better, twenty minutes spent in the gymnasium on the cross-bar, ladder, or parallel-bars.

Nothing can be a greater mistake for one who is anxious to succeed at cricket than to trust to the exercise got whilst playing *at* cricket, and to consider it to be sufficient. A long course of bowling, or a long three-figure innings will give to the bowler and batsman a sufficiency of exercise, but a long hang-about waiting to go "in," and when "in," remaining it may be only five minutes, may be the greater part of a day's work. When the batsman goes in, he may be stiff and weary of waiting his turn, and if he has not had walking exercise that day he will soon get out of breath, and will be in such a condition that he cannot, with his heart going irregularly and his chest heaving, make a long stand against good bowling. When a man is out of condition he cannot make a long score. Big scoring is very largely a test of one's health and physique. In the case of a strong, healthy, big-chested man in good condition, the running between the wickets is undergone with but little effect upon the circulation and respiration; but the running between the wickets causes a weaker man, especially if out of condition, to become breathless, it unsteadies his hand, obscures his vision, and renders it well-nigh impossible for him to continue. Any one who pretends to play cricket at all can make ten or twenty runs against ordinary bowling, but when it is a question of high scoring the difficulty increases directly as the score rises, so that it is more difficult—*i.e.*, it is a greater test of physical endurance—to put on ten runs to one's score between seventy and eighty than it is between twenty and thirty. Cricket is a greater test of physique, and of that nice balance that ought to obtain between heart and pulse and vein, than of skill. The healthier man, other things being equal, will make the better cricketer.

It is not customary for our professional cricketers to attend to exercising themselves: they believe that they get sufficient exercise from the fact of their engaging in a match. Now, if a man be a bowler, or if he makes a long stand at the wicket, he may for that day have done enough to keep him sound in wind and limb; but he may make a short stand, he may have to hang about a whole day whilst his "side is in," he may not be a bowler, or may have a near "field." A man following this regimen day after day, and week after week, cannot but get out of condition. The temptation to smoke whilst waiting about, to consume beer and spirits when the weather is chilly or wet, all add to the likelihood of his being upset after a time, or render a great success in the field well-nigh impossible. By those about to follow a season's cricket let the following rules be obeyed:—

1. Get out of bed not later than 6.30 a.m., this being summer-time.

2. Take an ordinary morning tub, or cold plunge-bath if it is available, in preference to a long swim in the river or sea.

3. After slowly dressing, write letters, &c., and meanwhile take a glass of milk and a biscuit.

4. At eight o'clock start for a brisk walk of not more than two miles.

5. Rest for a quarter of an hour after returning from the walk before having breakfast.

6. At breakfast eat either eggs (two or three) and bacon, a chop, steak, or a boiled or fried sole; in fact, anything that "agrees" with one, and which experience has shown to be easily digested. Drink coffee three parts milk, and eat stale bread, not hot morning rolls.

7. After breakfast stroll about for half-an-hour reading the paper, &c., and even indulge in a pipe, cigar, or cigarette. A pipe after breakfast is to a smoker the most enjoyable of all the day, and although it is usual to condemn it, as being an emblem of lazy and good-for-nothing men, it is very probably nothing of the kind.

8. A walk of two or three miles to the cricket field will do good. Do not, however, start on an eight-mile *walk* to the neighbouring village to play a match.

9. Get into flannels only just in time to go in the field, or to go "in" to bat.

10. If a long stand is being made, sitting still or loitering about is the worst thing possible. Get a ball and practise catching, or get a bat and defend a walking-stick even from the bowling of a country bumpkin. Should there be a tennis or fives court, or the possibility of a game at racquets, have a game in moderation at any one of them.

11. At luncheon eat a chop, one potato, or a piece of stale bread, and drink a glass of water. When one has to put up with what can be got, beware of shandy-gaff and ginger-beer. A glass of mild table ale, or Anglo-Bavarian ale, may be taken with advantage by men, but boys of fifteen and thereabouts ought on no account to touch beer, or anything except water, if they wish to be fit for anything after luncheon. How pluckily a match between boys is carried on until the luncheon-hour arrives; then comes a period of stuffing with buns, biscuits, bread and cheese, ginger ale, and beer. With such a mixture in one's stomach pressing on the heart and lungs, and muddling one's brain, it is no wonder that the luncheon-hour so frequently proves fatal when a school eleven plays a match with grown men.

12. Change the clothing as soon as possible after play is over. When it is possible sponge the body with cold water.

13. Rest for at least half-an-hour before taking dinner. Dine not later than 7·30 p.m. Eat what you please, so long as it is digestible. Drink a glass or two of ale, or, if preferred, one glass of sherry. Take nothing after dinner except a small cup of black coffee with the least bit of sugar.

14. If smoking is indulged in, one pipe or one cigar may be smoked not later than one hour after dinner.

15. Get to bed not later than 11·30 p.m. If you go to bed very early—say at nine or ten o'clock, make a point of getting up early; do not spend more than seven hours in bed, if you wish to get your muscles into working order. Lying in bed causes relaxation of the muscles and rheumatic pains; and in people who persist in staying eleven or twelve hours in bed nightly, fatty degeneration of the muscles and heart must ensue simply from over-rest. What a killing of precious time is done by such people, who well-nigh spend their lives in their bedrooms! They are a non-productive useless blot in this working world, and it is a good thing disease does come to rid us of such.

The dangers in the cricket field are :—

1. When a belt is worn around the abdomen, there is an especial predisposition to rupture. As often stated previously in this article, a belt, if it is to be worn, can only be safely worn when placed below the top of the haunch bone.

2. Inflammation of the lungs (pneumonia), pleurisy, and rheumatism may come from wet and cold; but much more frequently from stretching one's self on the damp grass.

3. Injuries from the ball by which any part of the body may be struck. The most dangerous parts to be struck are, the abdomen and head. Blows upon the former may cause shock and collapse, blows on the latter insensibility and even death.

4. A middle-aged man may set up aneurism, apoplexy, or lung troubles from over-exerting himself on the cricket field.

From this formidable list let not the reader turn away in fright, lest he himself, his brothers or sons, may get injured. One is safer on the cricket field than in the street—hundreds more are run over than are even injured at cricket; one is safer on the cricket field than in a country lane—more people being injured by furious cattle than ever are by bat or ball; one is safer on a cricket field than in one's house—more people being burned to death yearly than are even struck by cricket balls. So whilst pointing out the dangers, it is the rather to show how they may be even reduced to a minimum than to scare parents from allowing their children to engage in our best and most glorious game.

Football.

The position football holds as a national pastime in the opinions of the community of this country is peculiar. Whilst all allow that some good may come out of it, still opinions are so pronounced that people are divided into two classes in regard to it—namely, the players and the detractors of football.

The non-playing upholders of football are not so numerous as the non-playing admirers of cricket; as may be proved by the comparatively small assembly of spectators at a great football match as compared with the concourse at a great cricket match. This may be accounted for partly by the season of the year at which football is played, but mostly by the lesser degree of interest the community at large take in the game.

There is not the same clearness in regard to individual doings as in most games; there is more acting as a body than in allied games, which, whilst it binds each member of a team close in the tie of friendship, does not present that newspaper clearness of action which is calculated to make a game popular.

To those who play football the game presents strong attachments; otherwise what could attract young men to journey some distance in cold weather, to strip in a cold tent or in the open air, to run the chance of getting their shins severely hacked, and to be in danger of broken bones and even death.

All these are accompaniments of football that cannot be got rid of, and yet thousands of recruits are yearly added to take part in a rough football scrimmage, and run the chance of many accidents. The greatest attraction football has is no doubt that it *is* rough, and that one is called upon to put forth one's strength in a form of sheer physical force against one's neighbour. Nothing is so pleasant to a young animal—nothing. It is implanted in the boy as it is in a lion's cub, and in both it must find expression.

In schools where games are not practised in winter months, boys fight, as force must be expended, and that too in some such fashion as stated. The ball is a mere accompaniment in the game, a something to afford an excuse for throwing, pushing, charging, or wrestling with one's neighbour.

Whilst thus leaning to the side of the majority, in regard to football, let us see what can be said for it.

In the first place it has been in this country the only out-of-door winter sport for many decades. Skating is so uncertain that it may be considered as a blank in a list of pastimes, and lawn tennis on asphalte courts is not yet general.

In the second place it does not occupy much time; hence it affords an opportunity to thousands to engage in it at least once a week. It is not expensive, again, allowing to the many a means of exercise.

In the third place it calls upon the pluck and courage of each individual more than does any other game. It encourages a dependence on one's strength, it teaches a boy confidence in himself, and insensibly moulds his character to the manly quietude of conscious self-reliance. These are qualifications fit to establish the game on a permanent foundation. It is a rough-and-tumble sport, but one at which a lad first tests his courage, where he first acquires that fearlessness of disposition which in after years teaches him to regard a dash at the enemy's trench as little more than a football scrimmage, or a charge at the enemy's guns as little more than charging an opponent who has "collared" the ball.

The exercise obtained at football is very variable, according as one plays forward, half-back or quarter-back, etc., and according as the game goes. When the game is open all may get a fair amount, as running is then the feature; but the occurrence of scrimmage after scrimmage is tedious to those engaged in it, tedious to the other players, and to the onlookers it proves fatal to their interest in the game. Were it not for these general *mêlées*, football would be more attractive. Association rules have done something to improve the game, as far as onlookers are concerned; but very many of the best clubs in England cling to the Rugby Union rules. Herein is one of the reasons why football does not become as popular as it might: namely, this division into Association, Rugby Union, Rugby, Marlborough, etc., rules. It is a house divided against itself, as it were; and football will never stand a first favourite in national sports with other than players and those immediately interested in it, until a complete and radical change is effected in its surroundings and attractions. One hears a haughty football enthusiast say, "We don't care to force the public to come to see us play; we get enjoyment, and that is enough for us." That is not the point; if football be a good thing for our boys and young men, it ought to be first in the *menu* of winter sports. One interested in the welfare of the nation, more than in that of the individual, would say, "Make this a popular sport, encourage the *nation* to come and look at you as happens in cricket, send each one away with a favourable notion of the game, and you will provide pleasant means of exercise to our young men suitable for our long winter months." What happens is usually the opposite of attractive; the game, after a succession of tussles, ends in a "try," or a "touch-down," or some equally unappreciable event. The "goal," which is the name associated with the result of a game of football, may be never attained, and the uninitiated cannot see which side is winning.

The question football men ought to put to themselves is this, How can we make this splendid game more popular? Do not flatter yourselves you *are* popular, for, with a few exceptions in certain districts, the general public care not for your game; they never read the newspaper acounts of your matches, and do not know the name of a club or prominent football player in the country. If you want to become more popular, provide shelter and comfort for your onlookers, stop scrimmages, extend the length of the ground, show the ball more, make the meaning of "tries" and "touch-downs" more clear, provide for more goals to he obtained—*i.e.*, show more result of a long game, and have the ball always on the ground.

Football is a misnomer; the game ought to be called foot and hand ball, for it is as much in the hand as on the ground nowadays. Football men smile at these suggestions, and say such a game would not be football. The suggestions given, however, would not make the present form of football so different from what it now is, as is the present form from that followed say thirty years ago.

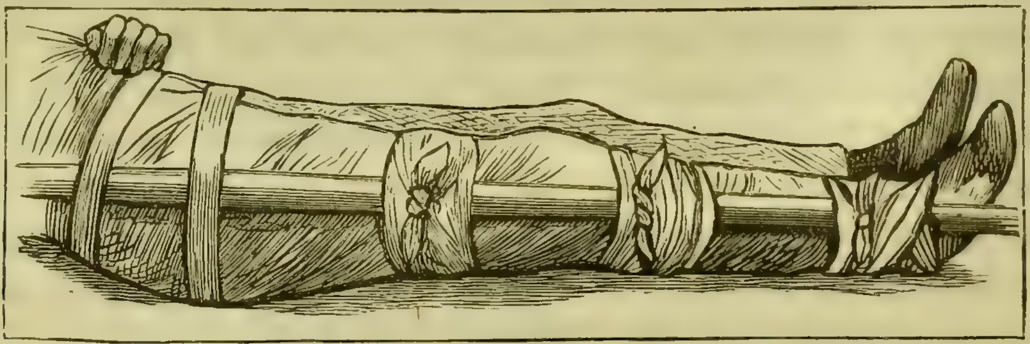

Fig. 9.—Goal Pole, or Broom Handle, applied as a Splint.

The following rules ought to be adhered to by football players :—

(1) When the football season is at hand, endeavour to get the circulation and respiration in good order by walks of at least seven miles a day, commencing at the rate of three miles an hour, and increasing it to four. Accustom yourself to running first at the double, and secondly, after some time, at a rapid hundred yard spin. Always practice running in a football kit.

(2) As football is an afternoon game, have luncheon two hours before the time fixed for the game. At luncheon eat a chop, one medium-sized potato, a glass of water or mild ale, and nothing else.

(3) See that when you strip, your wearing clothes are hung up away from damp and wet; attend to "airing" and drying your football kit before leaving home.

(4) Never be induced to drink beer or spirits during play.

(5) Do not during a cessation in the game, from any cause, lie down on the ground, however temptingly soft and dry it may seem. This is one of the greatest dangers of football, as it is the frequent cause of chills and colds, giving rise to pleurisy, inflammation of the lungs (pneumonia), colic, rheumatism, and the like.

(6) Change every stitch of clothing when the game is finished, and at once. A rub down with a wet sponge and rough towel is refreshing, and likely to prevent chills during the journey home.

(7) Immediately one is dressed, a cup or two of tea is the best drink.

(8) Do not smoke until at least half-an-hour after the game is finished.

Accidents are so frequent during football, that they must be considered normal accompaniments of the game. Here are appended a few rules to be followed when serious accidents occur at football or other field sports :—

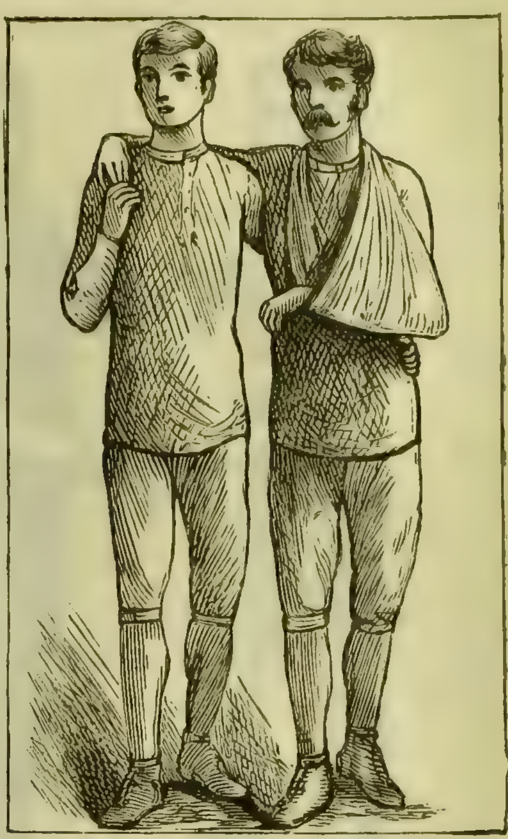

Fig. 10.—Method of Helping a Person suffering from an Injury to the Foot or Leg.

1. When the "thigh-bone is broken," it can be recognised by the man immediately falling, by his inability to move the limb, by the inequality in the length of the two limbs, by the twisting of the foot, by swelling occurring in the course of the broken bone, and by the bony grating or "crepitus" given out when the fragments are moved. The "first aid" to be rendered in the event of no doctor being present, is to—(1) Pull upon the foot of the injured side until the two feet are brought side by side. (2) Hold the limb in this position firmly. (3) Take a goal pole and, breaking it, adapt it so that it may reach from the armpit to the foot. (4) Place a folded newspaper, jersey, or the like on the inside of the injured thigh. (5) Fix the appliance to the limb by handkerchiefs, tying them round the ankle, the knee, the thigh, and body; finally, tie the two limbs together. (See Fig. 9.)

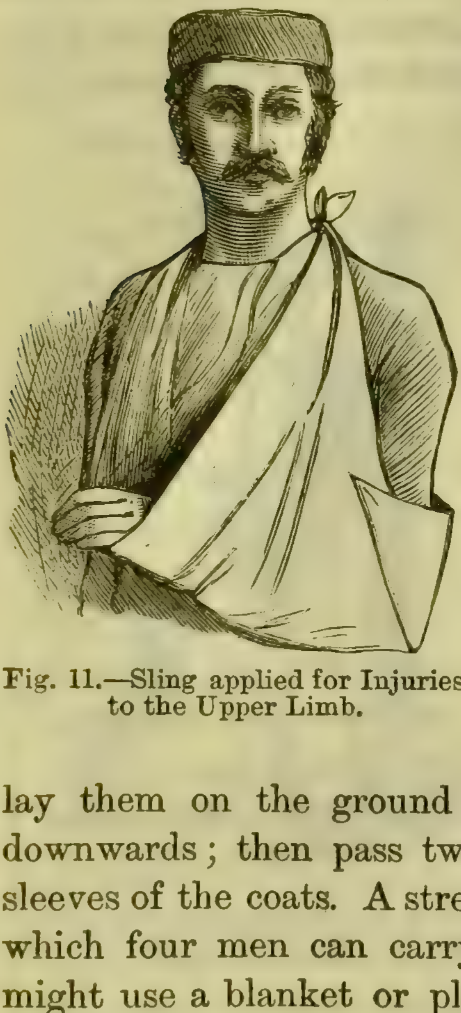

Fig. 11.—Sling applied for Injuries to the Upper Limb.

Now take two great-coats, invert the sleeves, and button the coats, sleeves inwards; lay them on the ground end to end and buttons downwards; then pass two goal poles through the sleeves of the coats. A stretcher is in this way made which four men can carry. Instead of coats, one might use a blanket or plaid as a stretcher thus :— Lay the blanket or plaid on the ground, place the goal poles on either side, and roll up towards the centre, leaving enough room for the patient to lie on. Four men can carry this, by grasping the pole and blanket with both hands.

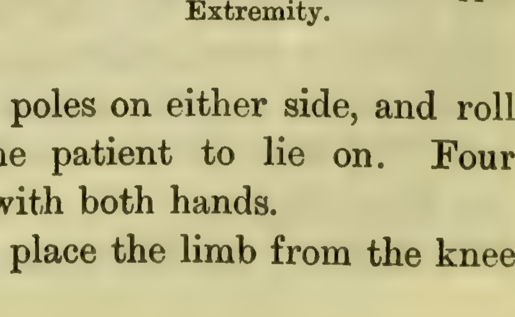

Fig. 12.—Angular Splint for the Upper Extremity.

2. Should the "small bone of the leg" be broken, place the limb from the knee

to the ankle on a great-coat rolled up from either side, or between two umbrellas or walking-sticks, fixing it firmly by tying handkerchiefs around; tie the two limbs together. Arrange an improvised stretcher as directed above.

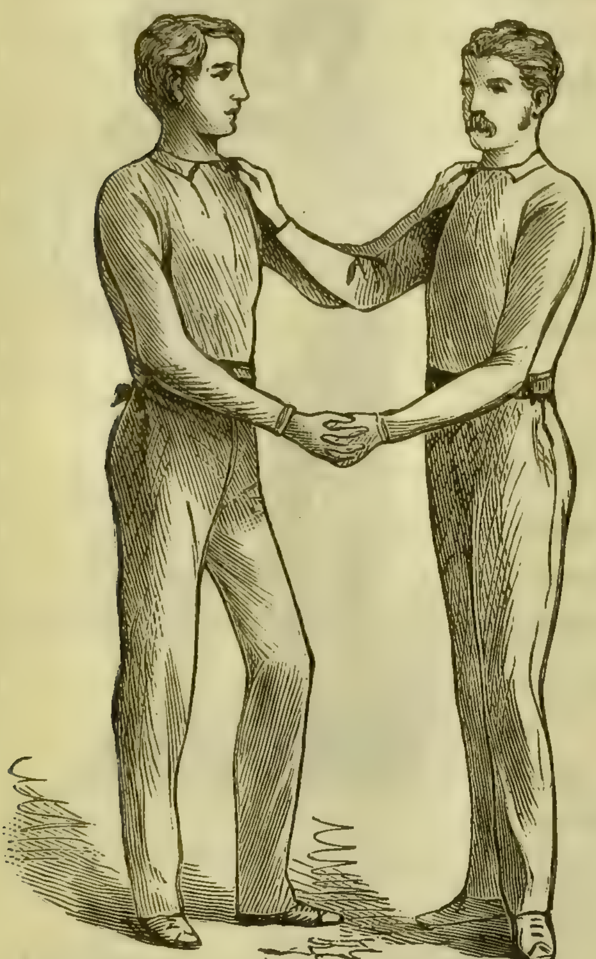

Fig. 13.—Two-handed Seat, with Support for the Back.

3. Should a bad bruise, a sprained ankle or knee, or a severe injury of any kind, short of a broken bone, happen to the lower extremity, help the injured person off the field in the manner indicated by the diagram (Fig. 10). The helper stands on the same side as the injured limb.

4. When a "broken collar-bone" occurs, it can easily be made out, by the arm dropping, and the crack in the bone being felt by the finger. (1) Place a large pad, *i.e.*, a folded waistcoat or the like, in the armpit of the injured side. (2) Bring the arm to the side and tie it to the side, by passing a handkerchief round the arm and body. (3) Apply sling. (See Fig. 11.)

5. Should the "bone of the arm," or one of those of "the forearm" be broken, place two sticks or tightly-folded newspapers crosswise, and tie them together as the diagram shows (Fig. 12). Fix the appliance by handkerchiefs, and apply sling.

In the event of a severe blow, knock-down, or squeeze, giving rise to shock, as is known by pallor, shivering, and complaints of cold—not insensibility—assist the patient to shelter, lay him down flat, cover him over with wraps, and give him some spirit to drink. When he comes round, send him home in charge of a friend.

6. "Broken ribs" is a common accident, and one that is recognised by pain, difficulty in taking a deep breath, and the possibility of feeling crepitus when the hand is placed over the seat of injury. Fold a neckerchief *broadly*, apply the centre of this over the painful part; tie the bandage only sufficiently tight to give the patient support and comfort.

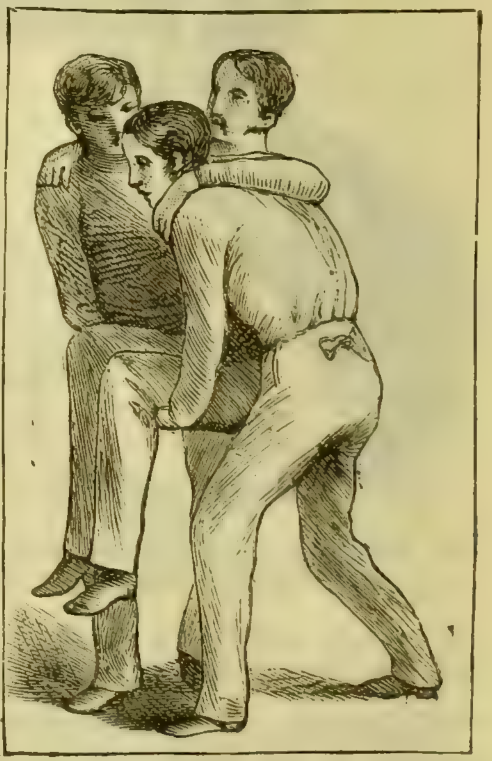

Fig. 14.—Two-handed Seat, with Support for the Back.

7. In the event of a man being stunned (rendered insensible) by a blow on the head—(1) Lay him down on his back with a coat or two beneath him. (2) Raise the head slightly. (3) Do not give stimulants or fluid of any sort during insensibility. (4) Leave the man quite alone for half-an-hour to see if he comes

round. (5) If at the end of that time he does not come round, prepare a stretcher and convey him to where he can be attended to.

A handy method of conveying an injured person is the sedan chair known to schoolboys, or any of the methods here delineated. (Figs. 13 and 14.)

Swimming.

It is a disgrace to the people of this country that to be able to swim is an attainment possessed but by few. Sailors and fishermen are no more proficient in the art than are other classes of the community. Round our coasts thousands of fishermen daily, nightly, and hourly court death by their inability to swim. This ignorance, worthy only of lower animals, is rife, and calls aloud for remedy. To men with minds so constituted that they continue in the enactment of such a sin, there is only one remedy—force. Let not the wages of such cattle ignorance be death from drowning; but let the rulers of the nation interfere and save them by compelling every man whose business is on the waters to become proficient in by swimming. Whilst thus urging the learning to swim upon this particular community, it is equally necessary to urge it on all, men and women alike. Would that some great writer or orator might arise to bring home to the minds of this maritime nation their duty in this particular; would that he could bring it home to the minds of parents, that by teaching a child how to swim, they may be teaching it to save its own life and the lives of others.

Baths and bathing are fully discussed elsewhere in this book, so that it is out of place to go into the effects of river and sea bathing, and the good and evil arising therefrom. But a word of warning is here necessary in regard to those learning to swim in rivers. Boys at school when they take to river bathing often carry it to a dangerous extent. They get into the water, and now in, now out on the bank, remain naked for hours and hours. This may take place day after day, and if the weather continues warm and the holidays last long enough, the boy may have reduced himself to the lowest ebb of feebleness, and possibly developed the seeds of latent disease. He may there and then become ill and die from the effects of this prolonged immersion and mad-cap exposure to cold, and henceforward learning to swim is, by all his friends and relations, forbidden in their families. This silly lad is the fearful example always quoted to deter any one intending to learn this most useful of all forms of exercise.

The muscular exertion undergone during swimming, especially by those who swim only occasionally, is very great. The experienced swimmer conserves his strength, as do proficients at all feats, but the occasional swimmer puts forth treble the energy required, and soon becomes exhausted. In the first place, it is a new act for the muscles to perform; they are taken off the beaten tracks, and are grouped together in new associations, hence they become exhausted soon. Again, as in other feats for which one is untrained, the heart and lungs do not work in time, as by and by the heart will be felt to be palpitating, and breathlessness causes the motion to be stopped.

After the initial acts of learning to swim are got over, the whole question of acquiring ease and speed depends upon the attainment of harmony in the working of the muscles, heart, and lungs. The attractions of swimming are:—

1. It is a mode of progression in a new element.

2. It is a change in the mode of progression, calling into play new groups of muscles.

3. Not only so, but the mode of progression itself may be changed from a breast stroke to a side stroke, which again may be semi-revolving; the position may be also changed to the back, when one may either urge one's self forwards by the legs, or lie still and rest.

4. The attaining greater proficiency from day to day is encouraging and enticing to a swimmer.

5. The effect of immersion for a short time in cold water is invigorating and good.

6. The learning an art, the most useful of all muscular feats.

Diving is an accomplishment attached to swimming, which involves many dangers, and is well-nigh useless. The customary dive off a spring-board into the shallow water of a swimming bath is dangerous in the extreme. The only place where diving should be attempted is into deep water, at least fifteen or twenty feet, where there is no danger of striking the bottom.

Lawn Tennis.

Of modern inventions in the way of games, Lawn Tennis is the best. It is suitable not only to young and middle-aged men but also to women. This is perhaps its greatest recommendation, and sufficient to establish it for ever. Indeed, it promises to become as much a national institution as cricket itself.

The advantages attaching to lawn tennis are:—

1. It can be played in a private ground, or at home with one's own friends.

2. It can be engaged in for a shorter or longer time at the pleasure of the players, and at any time of the day.

3. It involves no standing about, waiting to "go in," as in cricket.

4. It is almost the only real exercise at which men and women can join on nearly equal terms, as far as strength, quickness, accuracy, and the attaining perfection in the game are concerned.

5. It involves no special previous training, as the engaging in the game affords the best training whereby to become more perfect.

6. It is usually played near a house, so that dressing and undressing in the open air or in draughts, and exposure to damp and wet are avoided.

7. It is more free from serious accidents than any other of the true exercise sports.

The dangers attendant on lawn tennis are:—

1. Over-exertion, causing rupture and deranged circulation, especially in the case of those with weak hearts, or those who, being out of condition, or too fat, suddenly engage in the game for too long a time, or too violently.

2. Rupture of the *tendo Achillis*, the tendon at the back of the leg, just above the heel, from taking a sudden bound. The occurrence of this accident is made

evident by the person to whom it occurs falling down, with the sensation as if struck a sudden blow with a club on the leg.

3. Rupture of one of the heads of the biceps muscle in the arm. This can be recognised by the sudden dropping of the arm, and by a muscular knob rising up on the inner and upper part of the arm.

4. The tennis arm. This is an occurrence that has given rise to much discussion, and already is recognised as a distinct trouble arising from the method of manipulating the bat. The pain is felt over the upper end of the outside bones, *i.e.*, the thumb side bone of the forearm—the radius.

There are two distinct forms of this accident, varying as to the structures affected and the seat of the pain. In one, the pain is over the head of the bone, immediately below and to the outside of the elbow, exactly over the head of the radius. This is caused by a wrench or tear of the ligament over the bone; felt when the forearm is pronated violently, *i.e.*, when the hand is twisted round previous to striking a back-handed blow at the ball.

The second seat of injury is about 1½ or 2 inches below the elbow, and is dependent on a wrench or tear of the muscle employed in the recovering the forearm from the position of the under-hand twist, necessary for the back-handed stroke when the ball is in certain positions. The muscle is a supinator (the *supinator brevis*), and it has a nerve (the *posterior interosseus*) running through its substance. The injury is either a tear of the muscle causing blood to be effused around the nerve, thus causing pain or pressure, or it is a wrench of the nerve itself. The only cure for this is rest from tennis for a month or two, or the wearing an elastic elbow-cap during play.

The reason for the strains, ruptured tendons and torn muscles so frequent in the lower extremities of those engaging in lawn tennis is not far to seek. It is caused by the want of heels to tennis shoes. Seeing that we are accustomed to walk on heels which vary from half-an-inch to one inch in ordinary cases, there must be a considerable extra strain thrown on the muscles of the calf of the leg when the heels are suddenly left off. Especially during a sudden spring is this apparent, when to rise from off the heels on to the toes requires a greatly increased force compared with ordinary movements; see then that tennis shoes have fairly deep broad heels. Let girls follow the rules laid down as regards clothing in the section on Rowing.

BALL-GAMES.

Many forms of games "with ball" are known, and some of them are very ancient, dating many hundreds of years back. The game that has supplanted the old forms in popularity is the modern game of Lawn Tennis. This is an extension, and a very clever improvement on the old game. It is a specimen of how games grow, and how tastes and requirements for exercise differ in the course of centuries. From the school-boy throwing his ball against a wall and catching it when it rebounded, the next step was hitting the ball back again, and trying how often that could be done without letting it drop. The game got then the name of *paume*, or palm-game. Next a glove was adopted whereby to protect the hand, and by and by a bat, or racket, was introduced, and the game was called *rackets*, or *racquets*. The principle of the use of the racket is the foundation of modern lawn-tennis, but the idea of the net is borrowed from the Indian game of Badminton. Thus it has taken hundreds of years to bring this game to its present form; and the history of many games is alike in the stages of their development.

Rackets, or racquets, is played in a court, 96 feet long by 33 feet wide, and surrounded by high walls; in such a court *tennis* used to be played, and *fives* are frequently played in this court, although, a high wall is all that is necessary for it. The principle of fives is much akin to rackets, and it gets its name from the number usually employed on either side. These games are excellent winter sports, as the air circulates freely through the court; in fact, they may be said to be open-air games. The only dangers to be guarded against are over-exertion and sudden twists to reach a ball.

Bicycling and Tricycling.

The means of progression by wheeled machines, although an introduction of yesterday, has already spread throughout the length and breadth of the land. Bicyclists are so numerous, that from John o' Groats to Land's End there is not a town, village, or country lane that they do not frequent; so numerous are they, that they have several journals devoted to the consideration of their sport; so numerous, that they have maps and guide books specially suited to their wants. The devotees are counted by tens of thousands, and now that the allied method of tricycling is introduced, old and young, men and women, those bent on pleasure, and those on their day's work are provided with a means of rapid progression, bringing health to the body and recreation to the mind. The discussion of this exercise, the most interesting introduction of modern times, would take up too much space in this article, so that only the important points can be attended to.

1. In the first place, bicycling and tricycling afford a new means of progression. The exercise is charming, in that it is a change, and enticing in its novel sensations.
2. The rapidity of travelling adds greatly to its attractions, giving a lively impression of each quickly varying scene.
3. The distance capable of being covered is again a source of attraction, giving scope for the outlet of energy in the strong, and encouragement to the invalid and feeble.

Taken altogether, this mode of progression presents innumerable attractions and few dangers. It imparts a glow to the cheek and strength to the body; and, whilst it is an excellent means of preserving health, it is a grateful restorer of tone to the tissues, and vigour to the body and mind.

Whilst thus strongly recommending bicycling to men, and tricycling to both men and women in health, they should never be taken as a means whereby to regain health, without first consulting a physician or surgeon or both.

Those suffering from any heart or lung affections, rupture, scrofula, joint disease, or such like, must not indulge in this method of progression without receiving the sanction of a medical man. For abdominal complaints, such as dyspepsia, congestion of the liver, constipation and the like, this variety of exercise is excellent. The infinite succussions communicated to the body, as in horse riding, are invaluable in getting rid of these troubles.

The muscular exertion in bicycling is small when the enormous results are taken into consideration. In the first place, the position of the rider is that of partial support and partial bestowal of the weight of the body as a means of progression; and this balance can be varied at the will of the rider and the character of the road travelled. The whole or part of the weight may be supported by the saddle, or the whole or part of the weight may be bestowed on the treadles as a means of progression. The enormous wheels now used compel the rider to be almost in the perpendicular position, thus affording a minimum amount of exertion to the lower extremities, and utilising the bodily weight as a means of progression. Take, for example, a bicycle with a wheel of 60 inches diameter; every stroke with the foot causes the wheel to travel half its circumference, or nearly 7½ feet—*i.e.*, 90 inches. This is equivalent to three regulation walking steps of 30 inches; and not only so, but the impetus given to the bicycle by one stroke would carry it much farther, whereas a step in walking gives no farther "way" on the body. Hence each stroke becomes lighter after the first, and less and less exertion is required to keep the machine in motion. From all these reasons, then, and from actual observation of the effect of comparative distances travelled, it is plain that to travel a mile on a bicycle is equivalent in muscular expenditure to about one-sixth of that expended in walking a like distance. The exertion spent in travelling a mile on the "level" on a bicycle is not more than four foot tons, so that as 300 foot-tons is the calculated amount of daily exertion necessary to expend to keep a man in health, an 80 mile ride can be undertaken by a man without danger of overdoing it. No road, however, is level or smooth; hence it is nearer the truth when the exertion expended is considered to be six foot-tons a mile; limiting the distance which ought to be travelled to less than 60 miles a day, if one is to keep within the bounds in regard to the energy expended. Of course, a healthy man can do much more than 300 foot-tons a day, but an exertion greatly over that amount cannot be continued day after day without injury to the health.

Tricyclists cannot travel so fast or so far as bicyclists. In the first place the diameters of the wheels of a tricycle are at present less than those of a bicycle; the friction of a larger amount of machinery, and the contact of three wheels with the ground instead of practically one, as in the bicycle, is a drag on rapid advance. In the next place the rider is not placed so favourably so as to bring the weight of the body to bear as a means of progression. Forty miles a day is about the maximum distance that ought to be attained on a tricycle, and at a rate of not more than six miles an hour. The muscular expenditure is largely brought to bear on the lower extremities, but this is prevented from becoming too great by the rider assuming the three-quarter erect position and by grasping firmly, rather than pulling upon the handles of the machine. In this way the weight of the arms are taken off the chest which is left free to expand. Beginners pull at the handles with too great force, thereby fixing the chest and diaphragm so as to give a point of resistance to the arm muscles. The consequence is the rider becomes breathless, his heart palpitates and his limbs ache, and he may give up the idea of learning to ride in disgust. The learning to ride under a proper director is simple in the extreme, and a few lessons will make the pupil independent of his master.

The dress of the bicyclist or tricyclist ought to be of tight-fitting light flannel garments; a change of clothing and a water-proof coat ought to be carried during a journey. Stop travelling when it is necessary to put on the water-proof coat. Always change the clothing at the end of a journey.

If possible take a tepid bath at the end of a long journey. Eat and drink as little as possible during the journey, and always *stop* to eat, even if it be only a sandwich. If you stop to have a chop, &c., do not start for at least an hour afterwards. Drink water with luncheon, and carry cold tea in a flask to drink on the road.

Space will not allow of the discussion of the numerous accidents incident to wheel progression, but the reader is referred to the latter part of the section on Football, for direction as to what means are to be taken to render "first aid" when accidents arise far from medical aid. In regard to the comparative advantages of bicycling and tricycling there is no doubt of the superiority of the latter for middle-aged people; the bicycle, however, attracts the young the more.

The bicycle is a more perfect machine than the tricycle, which presents many more mechanical difficulties to surmount. In the future, tricycles must be made so that the work will not have to be done at such a disadvantage as at present, and the rider must be more "over" his work. Again, the rider must be higher up from off the ground, if pleasure is to be gained at the same time as exercise, by tricycling. The bicycle is complete in this respect, raising the rider higher than in walking, affording a view over fences and hedges, and thus relieving the monotony of the road. The bicycle rider is independent of stables and horse, his carrier can be mounted at any time, he can issue forth early or late placing ten miles between his resting-place and the breakfast hour. He can from his wiry perch, on the top of his silent wheel, watch the first tear that glistens in the opening eye of morn, the dawning day, the noontide refulgence, the weary waggon on its homeward road proclaiming the dying day, or the moonlit quietude of pastoral peace; the townsman can be carried to country lanes, to fields and pasture, at a cheap rapid rate, enjoyable in that it is rapid, and pleasurable in that it is by self-exertion that the joy is being attained.

Gymnastics and Calisthenics.

In the widest sense of the word, gymnastics includes every regulated movement for the purpose of perfecting and maintaining the strength of the framework of the body. In the days of the early Greeks, gymnasia were the chief places where manly sports of all kinds were indulged in. The Greek word γυμνος (gymnos) signifies "naked;" but although we of to-day mouth the word, we practise not its spirit, and our gymnasts appear tightly corded, laced, and artificially bolstered up to perform their feats of strength. The Romans called their places of exercise "Thermæ," where the bath and the gymnastic area were under the same roof. Magnificent buildings, in many instances enclosing enormous areas, provided ample space for exercise, and no doubt did a vast deal of good to the physique of these nations. When hand to hand conflicts were the only form of fighting, men possessing the best trained muscles prevailed. In these early days out-of-door sports were almost unknown, and hence the nation which provided the best and the greatest number of gymnasia was usually in the ascendant. As first one and then the other of these nations allowed their gymnasia and thermæ to become used for other purposes—when the orations of the philosopher caused young men to leave their sports and talk politics, when the luxury of the warm bath became more attractive than the manly sport, then did the gymnasia and the thermæ decline, and become, in many instances, disreputable dens.

The gymnasium of to-day, as we know it, has not the national significance it had in times gone by. Out-of-door sports have gradually robbed it of many of its most important rôles, until little is left except artificial movements and muscular feats, which may be important as performances, but stand in poor comparison with the good derived from English sports. A few good gymnasia there are in this country—that at Oxford being perhaps as complete as any; and the German gymnasium, and some others in London and a half-dozen of our largest towns, must not be forgotten. On the continent, especially in Germany, much more attention is paid to this subject. Many of the gymnasia are in enclosures, open to the air either altogether or in part, so that fresh air is breathed during muscular exercise; and to nations having few out-of-door sports worthy of the name, gymnasia are, when well conducted, a great boon. Without such places of exercise what have our continental neighbours to make up for the want of national sports corresponding to our own? They have military drill, and that, fortunately for their physique, is compulsory. What Englishmen find in rowing, racing, cricket, football, and the like, our neighbours find in "drill." Beyond all doubt, it is a good form of exercise; drilling, with a rifle to carry, not only gives the upper extremities work, but the continual marching provides what the gymnasium cannot—viz., exercise for the lower limbs. It is this last fact which tells against the present-day gymnastic performances; they afford exercise to the upper extremities, and the upper part of the body, to the neglect of the lower. Examine the means provided in any gymnasium for exercising oneself; they are found to be—the cross-bar, parallel-bar, dumb-bells, rings, trapeze, ladders, and the like, all calculated to develope the upper extremities only. It is only boxing, fencing, and wrestling which call for activity in the whole body, and even these sports do not give sufficiency of exercise to the lower extremities. So that our gymnasia, docked of running and leaping as in ancient days, are calculated to develope the upper but not the lower part of our bodies, and as the exercises are performed in the midst of bad hygienic surroundings, the real good that comes of the practice is doubtful. A feature in the gymnasia of to-day is that they are used as means of restoring health to young and old. Surgeons and physicians recommend them; very often, it is to be feared, in a careless, off-hand sort of way, without ever troubling themselves to ascertain what it is they have recommended, or with but the vaguest notions of what the inside of a gymnasium is like. A few good managers and teachers will have nothing to do with a pupil-patient unless a certificate from the medical attendant is produced. Then the exercise is tempered to the disease, and good may come therefrom; but numerous trainers only advise their pupils to see a doctor after they have been made ill by some mismanagement.

The subject of Calisthenics is one which does not admit of separate handling. It is a school-girl edition of the extension motions practised in military training. It is at times taught by a drill instructor, and at times by the dancing teacher; it is, by the latter, placed in the programme between dancing and deportment, and it is believed to have been taught when the course is ended. When it began, and when it ended, the pupil is not conscious of, and the teacher does not explain. In an amateur way the mother of a family educated at a boarding-school in calisthenics inflicts the like on her daughters, and insists by fits and starts, by way of punishment for stooping, &c., a course of twisting about with long poles and elastic cords. Purposeless and useless for the most part, the exercises take the place of more useful means of bestowing grace and natural movement on the figure. Strengthen the muscles of the back by moderate walking, exercise out of doors without stays, and the stooping shoulders will disappear, and the girl who requires artificial support will be restored to her natural state. Drill, even in the modified form taught at boarding-schools, is a great boon to boys and girls alike, and it would be more so to girls were it regularly taught, and could the schoolmistress be induced to allow her pupils to lay aside all tight garments during exercise. What good is got from exercise is undone by stooping over desks, and by unnatural confinement of the organs of the chest and abdomen.

From all this, then, let us learn that there are but few sports, pastimes, or recreations which provide a complete exercise in themselves. Just as the rowing man must walk, so the pedestrian can only attain perfection in the balance of the muscular, respiratory, and circulatory system by some exercise calculated to develop his upper extremities and his chest space.

Take it all in all, it is greatly to the advantage of the youth of this nation that gymnastics, as practised in the gymnasium, are at a discount: that for one who is content to pass two hours in the stuffy atmosphere of a gymnasium, scores prefer our manly English sports, which afford means of making friendships, train our young men to hardihood, teach them self-reliance, and have much to do with framing the healthy tone in sport, in war, or peace, which stamps the modern Englishman.

THE INFLUENCE OF DRESS ON HEALTH.

By Frederick Treves, F.R.C.S. Eng.

Assistant Surgeon to and Lecturer on Anatomy at the London Hospital.

Introductory—The Primary Objects of Clothing—The Materials used in Dress—The Comparative Value of Dress Materials as Articles of Clothing:—1. Warmth; 2. Hygroscopic Properties; 3. Porosity; 4. Impermeability to Water; 5. Inflammability; 6. Power of Absorbing Odours; 7. Electrical Qualities; 8. Certain Poisonous Dyes—Underclothing—Fit Clothing for Exercise—Objections to Woollen Underclothing—Night Attire—*Male Dress*—The Head—Hats, Caps, etc.—The neck—The Trunk and Extremities—*Female Dress*—The Head and Neck—Bonnets, Veils, etc.—The Trunk and Extremities—Underclothing—Tight Sleeves—Tight Lacing—A Hygienic Costume—The "Divided Skirt"—The Hands—The Feet—Stockings—Boots and Shoes—High-heeled Shoes—*The Dress of Infancy and Childhood.*

INTRODUCTORY.

Profound and manifold are the interests that centre around the exclusively human property of clothes-wearing. These interests depend for their importance not so much upon their number or their variety as upon their intensely personal character. There is, as Thomas Carlyle has shown, a Philosophy of Clothes; and probably there is no branch of philosophy that is better understood, or that is more acceptable to the every-day world of men and women, than is this phase of the thinker's science. It may be no exaggeration to say that there are some to whom dress presents an interest that transcends all other interests. It may require no long journey through the world to meet with the spectacle of a woman gloating over some gorgeous novelty in apparel with the rapt devotion of a fetish-worshipper; or the spectacle of a man who will devote some hours of intense cogitation to the proper selection and arrangement of a neck-tie. There are, it would appear, few great interests left unconcerned in this matter of clothes. Dress has a practical as well as a theoretical concern in morality. It assumes a by no means unimportant place in the science of society. It is of much consequence in all those studies of mankind that regard him from his stand-point as a gregarious animal. It has, moreover, an æsthetic aspect, a concern in the science of ornament, and a part in the elaboration of what is vaguely known as taste. Especially must be noted those remarkable attributes of clothing that are concerned in a study of ceremonial dress. And lastly, and with no attempt to complete the list, there are interests in dress that are not dimly associated with the details of pride, vainglory, and hypocrisy.

Now, this present chapter is concerned with but *one* aspect of the dress matter, with but one single feature in the "Clothes Philosophy"—the influence of dress on health. It must at once be confessed that it is not the aspect of the question that excites the greatest amount of interest among men and women. In criticising any article of dress, the points that, as a rule, first claim attention have reference to the beauty and attractiveness of the garment, its costliness, the opportunity it affords for display, and its suitableness to the individual who wears it. When all these points have been passed in review and disposed of, the question of health may possibly be entertained, and the hygienic influence of clothes taken into consideration. It would require but little argument to show that there are no interests involved in this matter of dress that are more important than are those that concern the health of the individual. The importance of these interests is to be measured only by the importance of human life, and by the value that attaches to the state of perfect health. And yet, as the world goes, these matters seem to be the least important elements in the criticism of dress. It would appear strange indeed if in the newspaper description of some conspicuous bridal costume attention should first be given to the hygienic aspects of the dress, and a minor importance attached to its costliness, its grandeur, and its marvellous ornamentation. Nevertheless, a bride, I presume, affords no exception to the common impression that perfect health is more desirable than attractiveness. This anomalous condition of things is readily explained on the simplest study of human nature. Health—if one might propound a paradox—is only noticed when it is absent. It is to those who are diseased that hygiene presents its greatest attractions, and, as the majority of the active members of society are to be classed with the healthy, it is a matter of no surprise that the hygienic relations of dress excite but scanty interest. Dress has, indeed, many positive attractions, while its health relationship must pose as a negative allurement.

These few preliminary remarks appear necessary, since the present chapter deals solely with but this one aspect of dress, and there are always difficulties and pitfalls in the way of a study of one especial attribute of a matter. These difficulties assume in the main a two-fold character: the tendency to exalt the special subject to a spurious and exaggerated position, on the one hand, and the difficulty, on the other, of discussing it apart from the perhaps more potent influences that surround it. In the first place, those who would consider dress *solely* from a hygienic stand-point, and who would permit no influences to act in the selecting and fashioning of attire other than the rigid laws of health supplied, would rob dress of its most valued attractions. They would render it expressionless, and, to a multitude of people, almost purposeless. To them a garment of monastic simplicity would serve both for the apparel of every-day and for the costume of State occasions. They would annihilate Fashion, and substitute a form in dress that would vie in monotony with the familiar attire of the human occupants of a child's Noah's Ark.

The second difficulty is not the less important, in that it involves a perfectly different state of things, and is, perhaps, the one most active in the present instance. To consider the matter of the influence of dress upon health fully and entirely, it must be discussed without prejudice, and without being unduly affected by those many attractions that attach themselves to the subject. Thus, to properly deal with the matter, one must commence its consideration free from many forms of bias: free from the bias that in the selection of dress beauty transcends all things, free from the bias that dress is but a vehicle for display, and free from the bias that public admiration is the sole criterion of its value. This object, I think, can be best attained by accepting, partly as a confession and partly as a kind of creed, an utterance of Herr Teufelsdröckh's that may well form a prelude to the entire matter :—" I—good Heaven !—have thatched myself over with the dead fleeces of sheep, the bark of vegetables, the entrails of worms, the hides of oxen or seals, the felt of furred beasts, and walk abroad a moving rag-screen, overheaped with shreds and tatters raked from the charnel-house of Nature, where they would have rotted, to rot on me more slowly ! Day after day I must thatch myself anew; day after day this despicable thatch must lose some film of its thickness : some film of it, frayed away by tear and wear, must be brushed off into the ash-pit, into the lay-stall, till, by degrees, the whole has been brushed thither, and I, the dust-making patent rag-grinder, get new material to grind down."*

The Primary Objects of Clothing.

The primary objects of dress are, I imagine, first, to afford a general protection to the body, and, secondly, to maintain it everywhere at a proper and equable temperature. To these two purposes must be added a third, for which, however, but a minor importance can be claimed : the purpose, namely, of dress to act as a vehicle for personal decoration and ornament. The first two of these objects express in a general manner the relations of dress to health ; the third concerns solely the decorative attributes of clothing. In all criticisms that are passed upon dress, from a hygienic or utilitarian point of view, these primary objects must be prominently put forth. They must form a standard by which various costumes and articles of apparel can be judged and compared ; and they should form the basis of our conception of that nebulous entity—*a perfect dress.* The perfect dress, so far as it can be described in general terms, should fulfil the following requirements. It should afford a proper protection to the body, and should preserve it in a proper degree of warmth. These ends should be effected without interference with any natural function, and without limitation of any natural movement. The material of the dress should be such as to exercise no injurious effects upon the parts of the body with which it is in contact. The costume, as a whole, should be in conformity, so far as the above requirements will allow, with the tastes and fashion of the time, and with the dictates of modesty. Lastly, the dress should be ornamented as the taste of the wearer directs, provided that such decoration does not distinctly oppose the conditions already mentioned. I think that a dress such as this may be fairly taken as a standard for comparison ; and in criticising any form of clothing it may not be unreasonable to judge of its merits by the closeness with which it conforms to the above details.

One of the most important practical points in connection with this present subject concerns the matter of ornament in dress, and upon this subject a few preliminary remarks may not be out of place.

It is against dress in its decorative aspects that the principal crusades of the hygienists have been directed. In this matter, as in many others, it is difficult to avoid extremes of opinion. It must be confessed that those who advocate what they are pleased to term "dress reform" are apt to entirely ignore the fact that decoration may very fairly be placed among the original purposes of clothing. In proposing their reform, they are apt to be influenced solely by scientific considerations of the laws of health, and with this influence strong in their minds, they have invented costumes of extreme hideousness, and of very limited adaptability. Certain of the advances in "dress reform" have, I think, led to the very dangerous idea that a healthy costume is of necessity an ugly costume, and that to follow in dress the dictates of health is to follow in fashion the dictates of frumpishness. Any form of dress that is the outcome *solely* of certain hygienic laws is likely, except by simple accident, to be unattractive, inasmuch as it ceases to be an expression of the inner life of men and women, and becomes but the visible embodiment of certain hard scientific facts. That it is possible to have a dress that is both healthy and attractive has been proved over and over again; and one has only to refer to the costumes of ancient Rome and ancient Greece to find examples of a dress that offended no law of health and no canon of beauty.

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* "Sartor Resartus," Chap. VIII.

The other extreme is, however, still more to be deprecated—the extreme of judging dress from no other than an æsthetic point of view, and of regarding it solely upon its possibilities for ornamentation and display. This view of things is the more dangerous in that it is the more popular, and the less conducive to man's general well-being.

Probably, the truth lies in the mean between the two. I would say that dress may be made the means for adornment in a multitude of ways, and to no niggardly extent, so long as that adornment does not offend against the two great primary objects of clothing. It is not every one who would wish their daily costume to be of Puritanical plainness; but if, on the other hand, they wish to make it a means for display, let that display be kept within the simple bounds of the laws of health. Such a demand is, I think, neither pedantic nor unreasonable, and its practical realisation would tax but lightly the ingenuity and resources of those who profess to clothe the outer man.

THE MATERIALS USED IN DRESS.

For the following brief account of the commoner materials used for clothing I am indebted to "Ure's Dictionary of Arts and Manufactures."

Wool.—The fleece of the sheep. The quality of the wool is improved by the domestic culture of the animal, and it also depends upon the part of the sheep from whence it is taken. The Angora, or Angola, wool is about the best variety, and almost equally well regarded are the fleeces of the Merino breed and the breed of Saxony. The length of the wool fibre is from three to eight inches, its width about $\frac{1}{1000}$th of an inch. The surface is seen under the microscope to be imbricated, as with scales. The finer and shorter wools are used for fine cloth, the longer and coarser kinds for "worsted pieces," "poplins," &c.

Flannel.—A plain woollen stuff of a rather open and slight fabric.

Cashmere.—A material made from the down of wool found about the roots of the hair of the Thibet goat. Imitation Cashmere is made in England and France, and is composed of various mixed materials.

Kerseymere.—A fine fabric, woven plain from the finest wools.

Linsey Woolsey.—A mixture of flax and wool woven into coarse cloth.

Alpaca.—The fleece of a genus of animals inhabiting South America, and including the llamas, alpacas, vicunas, &c. The fleece is longer than that of the sheep, averaging six inches. It is soft and strong, and is commonly made up with cotton or silk.

Mohair.—The hair of a goat inhabiting the mountains in the vicinity of Angora. It is used in the construction of many materials—*e.g.*, plush, braid, a form of Utrecht velvet, &c. It is also woven into a light cloth that is to a certain extent waterproof.

Silk.—The thread spun by the silkworm. Each filament measures about $\frac{1}{2000}$th of an inch in width. It forms the strongest and most tenacious of textile fabrics. A thread of it is three times stronger than a like thread of flax, and twice as strong as a like thread of hemp.

Satin.—A silk stuff, so woven and prepared as to present a smooth and polished surface.

Velvet.—A silk fabric. The "pile" is due to the insertion of short pieces of silk thread doubled under the weft, or cross threads. These stand upright so thickly as to entirely conceal the interlacings of the warp.

Crape.—A Bolognese invention. It is made of raw silk, gummed and twisted at the mill to form a gauze-like fabric.

Taffety.—A light silk fabric with a considerable gloss.

Moire and Brocade.—Ornamented silk fabrics.

Plush.—A kind of velvet, made of silk, or of cotton, or of silk and cotton. Sometimes made of goat's or camel's hair, or of wool.

Cotton.—A filamentous down which invests the seeds of the gossypium plant. The threads are ribbon-like and twisted, and measure from $\frac{1}{800}$th to $\frac{1}{2000}$th of an inch in width.

Calico.—Cotton cloth. Is extensively printed.

Fustian.—A common twilled cotton cloth of a stout fabric, which receives no ornament in the loom, but is most frequently dyed after being woven.

Jean.—A twilled cotton, usually striped. Is sometimes made of silk.

Velveteen.—A cotton fabric, so woven as to imitate velvet.

Muslin.—A fine cotton fabric.

Flax.—The fibres of the flax plant, *Linum usitatissimum.*

Linen.—A cloth manufactured from flax.

Cambric.—A very fine and thin linen fabric, first made at Cambray. It is imitated in cotton.

Lawn.—A very fine linen material.

Jute.—The fibres of two plants, the *Corchorus olitorius* and *Corchorus capsularis.* It is used in the manufacture of certain coarse fabrics, and in the production of certain imitation goods.

The Comparative Value of Dress Materials as Articles of Clothing.

The qualities that may be considered under this head are very numerous, and appeal to many and varied interests. I propose to deal, however, only with such properties of clothing materials as concern, directly or indirectly, the matter of health. This limitation, although it considerably narrows the subject, by no means makes it of insignificant extent. It excludes numerous details that would probably represent to many the most interesting features in connection with dress—such as, for example, the comparative costliness of materials used in clothing, their æsthetic properties, their adaptability for decoration, their suitableness for certain individuals and for certain circumstances, *et hoc genus omne.*

In the following paragraphs the properties of certain dress materials will be discussed under these heads—1. Warmth; 2. Hygroscopic Properties, or the Property of Absorbing Moisture; 3. Porosity; 4. Impermeability to Water; 5. Inflammability; 6. Power of Absorbing Odours; 7. Electrical Qualities; and 8. Certain Poisonous Dyes.

1. *The "Warmth" of Clothing.*—It is a matter of the very commonest

observation that certain garments are "warm," while others are described as being "cool." It is perhaps needless to say that articles of clothing possess neither warmth nor coldness in themselves. What is meant by a warm garment is one that is capable of retaining the natural heat of the body, while the cool garment, so called, allows that heat to escape, and brings the surface of the body more immediately under the influence of the cooler atmosphere that surrounds it.

To properly understand this matter of the warmth of clothing it is needful to take some note of the facts and circumstances of animal heat.

By *animal heat* is meant the natural heat that is developed within the bodies of man and animals. This heat depends upon many complicated conditions. In great part it is the product of certain chemical processes that are perpetually active in the body, and that themselves are due to the continuous disintegration and building up of the animal organism. There are certain articles of food that figure especially as "heat producers," having indeed that sole function. There are certain tissues of the body itself that are "heat producers," and among them may be mentioned the muscles, the liver, and the brain; for activity in these various organs adds an increment of heat to the general temperature.

The average temperature of the external surface of the body is 98·6° Fahr. This temperature is subjected to certain but slight variations. Thus, the average temperature of the female is stated to be very slightly higher than the male. The temperature of infancy and old age is somewhat higher than that of adult life, although the powers of resisting cold at the two extremes of life are markedly less. The period of the day has some influence upon the warmth of the body, the minimum temperature being reached at night or in the early morning, the maximum late in the afternoon. These differences, however, do not extend beyond 1° to 1½° Fahr. Active exercise raises the temperature, but not more than 1° or at the most 2° Fahr. The sensation of heat after exercise may be great, but it is only a sensation. The heat of the body is the same in temperate and tropical climates, although the *sensations* of warmth experienced under the one climate may be more marked than those felt under the other. In like manner, the animal temperature in summer is never more than from $\frac{1}{5}$° to $\frac{1}{3}$° Fahr. above that in the winter.

The animal temperature must be *regulated;* for the body would become unduly heated if means were not afforded for a constant loss of a certain amount of animal warmth. When the body heat has effected its purpose it is necessary that it should be removed, and this is effected mainly through the action of the skin. It is especially important to note in connection with the subject of clothes that at least 70 per cent. of the whole amount of animal heat lost is lost through the integument. It is lost in three ways. Heat is *conducted* away from the surface of the body; it *radiates* also from that surface, and, in the third place, a great deal of heat is lost by the *evaporation* of moisture from the same part.

The moisture is commonly known as perspiration, and it is important to bear in mind that the body at all times, and under all ordinary circumstances, is perspiring. When the weather is hot, the skin perspires more readily, additional material for evaporation is provided, and the body becomes more rapidly cool. In winter, however, the skin perspires but little, evaporation is inactive, and the loss of heat from the surface of the body is thus reduced to a minimum. After exercise, the body sweats, and the necessary cooling of the heated surface is effected by the evaporation of that moisture. It will be understood that the evaporation from the skin, if very rapid, may lead to too sudden cooling of the body. This would be illustrated by a man who, when perspiring after exercise, stands in a current of cool air. The process is then conducted with great rapidity, and the individual "catches a cold." Lastly, it may be noted that evaporation is much influenced by the amount of moisture in the air, and that the drier the air the more rapid the process.

It is now necessary to consider how clothes contribute to the warmth of the body, and what is meant by the "warmth" of clothing.

In the first place those materials that are bad conductors of heat will the best maintain the body at an equable temperature. In cold weather their non-conducting properties do not permit the natural heat of the body to escape in any but the tardiest manner, and, on the other hand, in a very hot atmosphere they are slow to conduct to the skin the heat that is without.

Taking the ordinary materials used in dress, it will be found that as bad conductors of heat woollen textures rank first, and with them furs and down. Then come silk and cotton, while lastly, as the best conductor, comes flax, the material of which linen is made. Thus, then, the greatest amount of "warmth" will be derived from furs and woollen goods, and the least amount from linen—facts that are matters of every-day experience.

Many experiments have been made from time to time to estimate the *comparative* conducting powers of these various materials, and not among the least interesting of these observations are those recorded by Count Rumford in the "Philosophical Transactions" as long ago as 1792. As a result of these and of other researches it may be said that if the conducting power of linen be represented by 100, then the conducting power of wool would be from 50 to 70. Thus, speaking solely of this matter of conduction, wool has twice the "warmth," as an article of clothing, that linen possesses. Between calico and linen there is not so great a difference, and that difference, such as it is, is expressed by the following experiment. Observations were made as to the comparative time of cooling of certain materials that had been heated to a given heat. It was found that while the time of cooling of linen was represented by 10½ minutes, that of calico was 11½ minutes.*

These remarks so far refer only to the material of dress, and it is now necessary to consider *the influence of colour upon the "warmth" of clothing*—a subject of considerable interest.

Colour makes very little difference with regard to heat radiated from the body. The colour of underclothing, considered solely from the stand-point of warmth, is a matter practically of no moment. It makes little or no difference if the garment worn next to the skin is red or blue or black, so long as it is of a material that will, as a bad heat conductor, maintain for the body a proper temperature. With regard, however, to heat that acts upon the body from without, colour involves

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[*] "Étude sur les vêtements chez l'homme et chez la femme dans leurs rapports avec l'hygiène." J. Cerviotti, Paris, 1871.

a considerable difference. As the chief example of this kind of heat, the heat from the sun may be taken. Experiments made upon this point show that the same material will absorb very different amounts of heat when dyed with different colours. The greatest amount of heat is absorbed by black, and the least amount by white.

The influence of colour upon the absorption of heat is shown by the following table*, which records the amount of heat absorbed in a given time by "shirting" of the same quality dyed with the various colours mentioned.

When white received	100° Fahr.
Pale straw received	102° ,,
Dark yellow ,, ...	140° ,,
Light green ,, ...	155° ,,
Turkey red ,, ...	165° ,,
Dark green ,, ...	168° ,,
Light blue ,, ...	198° ,,
Black ,, ...	208° ,,

Dark blue, it may be added, absorbs almost as much as black.

An interesting demonstration of the different powers of absorbing heat possessed by deeply coloured materials on the one hand, and those that are simply white on the other, is afforded by the following experiment. Put a fragment of the common willow-pattern plate into a bright fire, and allow it to become heated to redness. Then remove it with tongs, and hold it up in a dark room, when the pattern will glow *white* upon a dark ground. This simply demonstrates that the dark colour of the pattern first absorbs and then gives off more heat than the white ground. A more direct and personal illustration of these facts, however, is afforded by common experience. The laws of the influence of colour upon heat underlie the selection of white and brightly coloured materials for summer wear, and the use of the more sombre tints for the cold days of winter. The brilliant colours of the tropics, and the less vivid tints that pervade the cooler zones, bear without doubt upon this same interaction between colour and heat. Many other facts illustrate the same relationship. By a very accurate experience the sailor wears a white jacket in the summer, and a deep blue coloured material in the winter. Cricket is an out-door game played in the summer, and it is not a little significant that ancient custom has established that white shall be the colour of cricketing apparel; while football, a winter game, presents us with individuals clad in a multitude of colours, of which the majority tend towards the deeper shades.

Another point to be considered in connection with the warmth of clothing is its influence upon the *evaporation* from the skin.

It has been already stated that the body is cooled—among other ways—by the constant evaporation of moisture from its surface. It is obvious, therefore, that any material used for dress that interferes with this evaporation must be considered as possessing qualities of warmth. This matter of the relation of clothing to the evaporation of body-moisture will be dealt with in greater detail subsequently. It will be sufficient in the present place to say that this relation depends mainly upon the power of the material for absorbing moisture on the one hand, and the impermeability of the fabric on the other.

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* "A Treatise on Hygiene and Public Health," by N. Buck, London, 1879. See also "Influence de la couleur sur le calorique" ("Annales d'hygiène," 1er série, t. xii., p. 54).

Certain materials used for dress absorb the moisture from the skin with rapidity, and passing this moisture on, as it were, allow it to evaporate from the surface. Such fabrics would tend to expedite the natural cooling of the body, and would be termed "cool" materials. Impermeable fabrics, on the other hand, will not allow of the escape of the perspiration. They keep the air that is in immediate contact with the skin saturated with moisture. Evaporation becomes more and more difficult; and if a garment impermeable to moisture is long worn it will cause a profuse sweating of the skin. It is for these reasons that macintosh garments are considered hot, and it is well known that even moderate exercise in a waterproof coat or cloak is apt to induce a free perspiration. The warmth, so called, of a macintosh does not depend—as does the warmth of the fabrics above discussed—upon its power of conducting heat, but mainly upon the effect it has upon the action of the skin. Macintosh is, indeed, a fair conductor of heat, and would be a cool material for dress if only it were permeable enough to allow of the escape of moisture. It is perhaps needless to say that the bodily heat encouraged and developed by macintosh and like impermeable materials is not a healthy form of heat, inasmuch as it depends in the main upon an interference with one of the natural and most important functions of the organism.

One more point remains to be considered in connection with this subject of the comparative warmth of dress. It refers to the property certain fabrics possess of *irritating or stimulating the skin.* If the skin be irritated, as by friction against a rough surface, the bloodvessels are encouraged to dilate, an additional amount of blood is thus brought to the part, and a sensation of increased warmth is experienced. With certain reservations it may be said that, other things being equal, a material with a rough surface will feel warmer than the same material with a smooth surface. It will be a matter, I presume, of general experience, that a rough woollen vest worn next to the skin will produce a greater sense of warmth than will a vest of like material but of smooth texture. The rough woollen material presents, projecting from its surface, millions of little irregular hairs and fibres that from as many points gently irritate the skin, and produce the effect that has just been mentioned. The degree of this irritation will depend upon many circumstances. In the first place, upon the susceptibility of the individual and the sensitiveness of his skin. There are some persons who cannot wear flannel or woollen materials as underclothing, because they produce upon an unduly sensitive integument so much irritation and such a disagreeable sense of warmth that their use cannot be persevered with. There are others who are conscious of but little difference between a rough under-garment and a smooth, and to such the additional warmth afforded by the skin stimulation is inconsiderable or not to be appreciated.

In the second place, it must be remembered that the body tends to accommodate itself to a variety of circumstances. The rough garment may irritate the skin at first, but after a while the integument becomes accustomed to the stimulation, and in time ceases to respond to it. The rough material has then become as little of an irritant as is the smooth, and any additional warmth that that irritant once involved is no longer felt.

The comparative warmth of tight or loose fitting garments, and other points incident to the subject, will be dealt with in a subsequent paragraph.

2. *The Hygroscopic Properties of Clothing Materials.*—By hygroscopy is meant the property of certain substances for absorbing moisture. The materials that are used in dress absorb moisture in very different degrees, and they are thus said to possess different hygroscopic qualities.

This property is of much importance in the hygiene of clothing. The advantages of materials that absorb moisture readily are these:—When an individual perspires freely, the garment promptly takes up the watery matter and diffuses it through its meshes. The water so absorbed by the garment undergoes, of course, evaporation, but the cooling effect of that evaporation is removed from the skin, where it might prove harmful, to the dress material, where it is comparatively harmless. Moreover, the moisture being thus removed upon the surface of the body, less is left in contact with the skin, and therefore the effects of evaporation upon that part are greatly lessened. A material that has feeble hygroscopic properties, when worn next to a perspiring skin, simply gets wetted. It does not remove the moisture from contact with the skin by taking it into its substance, but allows it to remain upon its surface, and proves a source for further cooling of the body. In noting the evil effects of damp clothes, it must be remembered that water is a better conductor of heat than air, and that, other considerations apart, a wet material removes the vital warmth much more quickly than does a dry fabric, the meshes of which are occupied simply with air.

The following table* will show the comparative value of certain dress materials with reference to the hygroscopic property. Each substance experimented upon was first weighed after it had been dried in a hot chamber for twenty-four hours. For purposes of subsequent comparison, it was arranged that each substance should start at the same weight (column No. 1). The materials made use of were then weighed again after they had been exposed for forty-eight hours in a cold, uninhabited room (results given under column No. 2); and, lastly, they were again weighed after an exposure of seventy-two hours in a damp cellar (results given under column No. 3).

	No. 1. Weight.	No. 2. Weight.	No. 3. Weight.
Sheep's wool . .	1,000	1,084	1,163
Fur	1,000	1,072	1,125
Eider-down . . .	1,000	1,067	1,112
Silk	1,000	1,057	1,107
Linen	1,000	1,046	1,102
Cotton . . .	1,000	1,043	1,089

Pettenkofer, adopting a different mode of investigation, estimated that the maximum hygroscopic properties of wool (flannel) were represented by 174, and the minimum by 111; while with linen the maximum was represented by 75, the minimum by 41.

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* See "British and Foreign Med. Chir. Review," vol. ii., 1859, p. 371.

Thus it will be seen that the greatest powers of absorbing moisture are possessed by wool, fur, and down, while the least amount of moisture is taken up by cotton. Linen is a little more hygroscopic than cotton, and silk is a good deal more potent in that direction. It cannot fail to be observed that this order very closely resembles that given when dealing with the warmth of clothing materials considered with reference to their powers of conducting heat.

The practical outcome of these facts teaches us that an individual who is perspiring freely is much less likely to catch cold when clad in flannel than when clad in linen. This especially applies to those who, while indulging in violent exercise, are exposed to changes of temperature or currents of air.

Flannel is the material very generally assumed by those who take vigorous exercise in the open air; it is the material, as a rule, adopted by the miner, who works in a cold or fluctuating temperature, and whose body is apt to perspire freely while in that atmosphere; and it is, indeed, a popular—perhaps the most popular—fabric for underclothing made use of by the labourer in the fields, as well as by the worker in the heated factory.

There is another matter in connection with this question of the hygroscopic properties of dress fabrics that must be mentioned, because it shows that the possession of this property is not an unmixed advantage. The disadvantage, I must confess, is very trifling, and its insignificance is the more marked when compared with the benefits that attend a hygroscopic material for these purposes. When a substance absorbs moisture, it of necessity increases in *weight.* That this increase in weight is not slight is shown by the above table, where it will be seen that the weight of a woollen material may be increased from 1,000 units to 1,163 by simply exposing it for some time in a damp cellar. It is desirable, for many reasons, that articles of clothing should be as light as possible, and it will be noted that the possession of good hygroscopic qualities somewhat interferes with this end. If an individual wearing woollen clothing of any kind (which we will assume is quite dry) were to occupy for some time a damp room, the air of which was charged with moisture, he would leave that room with more than 10 per cent. added to the weight of all the woollen garments he might be wearing. It is a matter deserving of note, although not one of great moment. When clothes, however, become actually *wet*, the increase in weight that woollen materials undergo is really considerable, and may even cause some inconvenience. Those who are interested in this matter should weigh a thick "Ulster" overcoat when quite dry, and again when quite wet, and the difference in weight will be found to be no trifling matter. These facts point to the unsuitableness of woollen fabrics when protection against actual wet and rain is required. Woollen garments afford excellent protection against cold and against changes of climate, but they are not suitable for those purposes for which "waterproofs" are usually worn. A long walk in the rain, clad in a macintosh, will be attended with disadvantages, but these disadvantages are outweighed by the discomfort of a wet journey in a thick "Ulster."

3. *Porosity.*—By the porosity of clothing is understood the ease with which air

is driven through the material experimented upon. This point has a practical bearing upon the "ventilating" properties possessed by certain dress fabrics, and their power of resisting the penetration of wind. The following table* shows comparatively the amount of air driven through certain materials during a given time and under a given pressure:—

Through Flannel	10·41	measures.
„ Lambskin	6·07	„
„ Linen	6·03	„
„ Washleather	5·37	„
„ Silk Fabric	4·14	„
„ Glove Leather	·15	„

This result corresponds with Pettenkofer's statement that flannel is more permeable to air than linen, in the proportion of 100 to 58. Thus it will be observed that the warmest clothing (flannel) may be the most porous.

4. *Impermeability to Water.*—Some of the points that may justly come under this heading have been already considered when dealing with the hygroscopic properties of clothing. I propose, however, to consider the impermeability of certain dress materials in the light of their capacity to act as *waterproofs.*

A textile fabric of almost any kind may be rendered waterproof by one or other of the following substances:—

a. Linseed oil, to which a drying quality has been communicated by boiling with litharge or sugar of lead.

b. The same oil holding in solution a little caoutchouc.

c. A varnish made by dissolving caoutchouc in rectified petroleum or naphtha, applied between two surfaces of cloth (Macintosh's patent).

d. A solution of caoutchouc applied to one side only of a single texture fabric.

e. A solution of soap worked into cloth, and decomposed in it by the action of a solution of alum, whence results a mixture of acid, fats, and alumina, which insinuates itself among all the woolly filaments, fills their interstices, and prevents the passage of water.

f. A solution of glue or isinglass, introduced into a stuff, and then acted upon by a clear infusion of galls, whereby the fibres get impregnated with an insoluble, impermeable, pulverulent leather.†

To these may perhaps be added the ancient and simple waterproof made by applying hot pitch or tar to the surface of some strong and open-meshed fabric. These processes are of different values for rendering materials impermeable to water. The two first-mentioned are but little used now for rendering waterproof articles of apparel, although they are still used for other purposes. Of the other methods, it can only be said that the most perfect waterproof is that manufactured with india-rubber, or caoutchouc. The material so prepared is as impermeable to water or to moisture as is a piece of porcelain. It has the advantage, moreover, of being light and supple, and is capable of being adapted to a multitude of purposes. If it be simply desired to have a garment that will keep out wet and rain, then it must be owned that the macintosh leaves nothing to be desired.

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* Parkes' "Manual of Practical Hygiene," 5th ed., London, 1878, p. 420.

† Ure's "Dictionary of Art Manufactures and Mines," London, 1860, vol. ii.

It will be noticed that there are two principal methods of making a fabric waterproof by means of caoutchouc. By one method the india-rubber solution is applied to one side only of a single fabric; by the other it is applied between two layers of the material used. The first plan is represented by the ordinary "macintosh," the second by what is commonly known as "macintosh cloth," the names in each instance being derived from that of the well-known firm of C. Macintosh and Co. Materials prepared by either of these methods are equally impervious to water, but the first-named method has certain decided advantages when applied to wearing apparel. The "macintosh cloth" can imbibe water by means of its outer layer of cloth. Thus when wet its weight is considerably increased, it takes some time to dry, and the evaporation from its surface produces a certain unnecessary degree of cold. The simple macintosh, on the other hand, can imbibe no moisture, the heaviest rainstorm will not add to its weight, and it requires no drying after wear. Its only disadvantage, perhaps, is in the matter of appearance.

As has been already stated, all "waterproofs" present this serious evil—that while they keep out all external moisture, they do not permit of the escape of the natural moisture from the surface of the body. Thus, if long worn, they produce a sense of unpleasant warmth and a feeling of oppression, while, by interfering with the process of evaporation, they allow a large quantity of perspiration to accumulate on the skin. The waterproof usually worn by ladies does allow in some degree of the escape of moisture from the body, but it is not impermeable to rain if tested in a severe shower. The great need is a waterproof garment so constructed that there shall be an opportunity for the escape of the moisture from the skin while its efficacy as a waterproof is unimpaired. It will be necessary to return to this subject when dealing with clothing in relation to times and seasons.

Silk and cotton fabrics become wet through sooner than do woollen materials of equal thickness, owing to the less amount of moisture that the former are capable of absorbing. They are soon saturated, and their protective powers against rain are consequently very limited. Fur acts, up to a certain time, as a good protection against external moisture. Its physical properties are such that for a while it keeps the rain-drops on its surface. Soon, however, the fibres of the fur become matted together, the water runs along them by capillary attraction, and it becomes saturated in about the same time that would be required for the saturation of an equal quantity of wool.

5. *Inflammability.*—In judging the comparative values of certain fabrics as articles of dress, it is important to consider the inflammability of those textures. This is especially important to those who are engaged in employments that render frequent contact with burning matters unavoidable, or that involve more than the usual risks of conflagration. Men so employed can usually form some rough estimate of the probabilities of their clothes being set on fire, and consequently take precautions in accordance with those probabilities. The well-known property of woollen fabrics to smoulder, rather than to break out into flame, when set on fire, renders their use very common with men following these occupations.

The resistance that stout leather offers when in momentary contact with burning matters is also well known, and makes the use of leather very general in factories and arsenals where fire forms an essential feature in the works. A woollen shirt and woollen cloth trousers, covered as far as possible by a good leather apron, form the usual attire of those who work extensively with fire, and it must be confessed that a better costume for all ordinary purposes is not to be desired.

Accidents from fire, however, are unfortunately not limited to iron-works and forges, and it is needful therefore to form some estimate of the comparative inflammability of the common materials of dress. All dress fabrics will burn when set on fire, but some while being consumed under an ordinary heat will simply smoulder, while others will break out into flame. It is, of course, with these latter that the great danger lies. They burst into flame, and consume rapidly, the flames soon reach exposed parts of the body, and it is possible that an individual clad with such fabrics may be burnt to death in the space of some few minutes. Materials that smoulder are obviously much less dangerous. They consume slowly, and allow time for means to be taken to extinguish the fire. The absence of flame, moreover, limits the burning to one spot, and prevents the simultaneous setting alight of other portions of the dress.

The following experiments serve to demonstrate the comparative inflammability of the common dress fabrics—wool, silk, cotton, and linen. A piece of each of these materials in a woven state is taken, placed upon a support of platinum foil, and held over a flame. Under these conditions the wool and silk will become charred without bursting out into flame, while the cotton and linen fabrics will burst into flame and be rapidly consumed. Then, again, thin strips of these substances are taken and are wound round a copper wire. The end of the strip of material is ignited at a flame, as a taper would be ignited. As a result it will be seen that the cotton and linen fabrics will burst into flame and will burn to the end, the flame coiling round the wire. With regard, however, to the silken and woollen materials, they can hardly be made to flame, and when flame forms it soon goes out, and unless re-ignited the strips will not burn to the end. From these and like experiments it becomes evident that, of the common dress materials, cotton is the most inflammable; then follows linen, which burns with almost equal readiness; next in order, but at a very appreciable distance, comes silk; and last of all wool.

Wool, then, of all these substances, is the least inflammable, and should afford the best protection against accidents from fire. It is well to observe, also, that the density with which any given fabric is woven adds to its power of resisting the rapid action of fire. A closely-woven woollen cloth will offer a better resistance to flame than will an open-meshed fabric made of a like material. In like manner, the more loose the weaving of a cotton fabric, the more complete and rapid is its surrender to the action of flame. It thus follows, then, that of all common dress materials, muslin is the most inflammable. It is made of fine cotton thread, and is of the most open possible texture, and it is to muslin that so many cases of severe and fatal burnings must be ascribed. The inflammability of dress materials is a matter that more closely concerns women than men. In the first place, the arrangement of the female dress is such that it is much more liable to the ordinary accidents from fire than is the less ample costume of men; and in the second place, the outer garments worn by men are usually made of cloth containing more or less wool, while women are often clad in dresses composed, in whole or in part, of the more inflammable fabrics. An ample muslin dress heads the list of dangerous articles of clothing, if we have special reference to this matter of inflammability; and when the dimensions of such a dress are increased by a large crinoline (as was the fashion once), it becomes simply an "infernal machine," and should be avoided with the care with which one would avoid a bomb of dynamite. During the period of time that crinolines were fashionable, the number of deaths from burning among females was simply terrible; for the crinoline not only involves an additional amount of the inflammable material, but it also aids the rapidity with which it burns by bringing it more completely in contact with the air. It must be observed, also, that all trimmings, especially when made of the more inflammable fabrics, add to the risk of the garment being set alight, and this applies more particularly to such trimmings as project from the surface of the dress, and so add to the points that may come in contact with unguarded flame. Among the poorer classes the common cotton dress is a frequent source of serious accident, owing to the readiness with which it takes fire, and this end is very often brought about through the medium of a cotton apron. Among the less wealthy orders, children are, perhaps, more frequently the victims of severe burns than are those who are grown up. The circumstance is not difficult to understand if one considers the peculiar tendencies and surroundings of children, and especially of neglected children. The garment that of all others brings about these unfortunate accidents is, so far as my experience of burns in hospital practice is concerned, a long cotton pinafore. A child tries to reach some forbidden object from the mantelpiece, or to peer into some culinary details, the pinafore hangs down in front of the fire, the draught carries its lower end against the bars, and it is promptly set alight.

Apart from this question of inflammability, it is well to note the protection afforded by certain dress fabrics when the body is exposed to intense artificial heat. The protection in such a case depends upon the value of the material as a bad conductor of heat; and the power, therefore, that certain fabrics possess of affording this protection depends upon their non-conducting properties. It is needless to say that woollen fabrics are the most valuable for this purpose, and the use of such fabrics to modify the evils of great heat are well known. The kettle-holder owes its efficacy mainly to the amount of wool it contains, and a woollen "holder" will better carry out its especial purpose than would one made of linen, even if it contained twice the amount of material. The protection thus afforded by woollen stuffs was well illustrated in the surgical report on a certain fatal accident in America some short while ago.* It appears that an excursion train came into collision with another train, the engine of which was actually thrust, or "telescoped," into one of the excursion carriages. One of the external pipes of the engine was broken by the collision, and an immense volume of intensely-heated steam was poured into the unfortunate car. A number of people were thus scalded to death before their escape could be effected, and an examination of the bodies, both of those who had died and of those who survived, revealed some striking facts. The weather being warm, the holiday party were lightly clad, and many of the women were clothed in the thinnest muslin dresses. These fared the worst of the whole party, and few so clad escaped with their lives. The extent of surface scalded and the depth of the scald depended mainly upon the nature of the underclothing worn. One or two of the occupants of the car wore woollen materials next to the skin, and these individuals were only scalded in such parts as were not so clad. The wool, indeed, had afforded a perfect protection. The least amount of scalding of the skin was found in those who were fortunate enough to have outer garments made of cloth containing more or less of this non-conducting material. The worst cases of scalding were afforded by those whose attire consisted solely of cotton or linen fabrics—fabrics possessing the unfortunate property (in this instance, at least) of being good conductors of heat.

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* "American Journal of Medical Sciences." 1881.

Before concluding this subject, attention must be directed to non-inflammable dress fabrics, or rather to the means adopted to render ordinary dress materials non-inflammable. These measures have been applied for the most part to muslin, as being the most dangerous dress material coming under the present category. As muslin is not only very ready to catch alight, but is also very commonly used under circumstances that favour accidents from fire, a non-inflammable muslin has justly been considered as a desirable object. To render this or other like fabrics non-inflammable, certain chemicals are used, and with these chemicals the material is saturated. It is necessary that the chemicals used should in no way affect the colour of the muslin, that they should not prove destructive to its fibres, that they should remain unaltered during ironing, and that they should be non-poisonous. It will be seen that these requirements—which are neither few nor trifling—will seriously limit the number of the materials that may be capable of rendering a dress fabric non-inflammable.

The following are the chief salts that have been used in the production of non-inflammable garments, the material selected being, as a rule, muslin.

a. Phosphate of ammonia.
b. A mixture of phosphate of ammonia and chloride of ammonium.
c. Sulphate of ammonia.
d. Tungstate of soda.

The objection to the first-named of these—the phosphate of ammonia—is that it gives to the muslin a somewhat chalky "finish," and for other reasons the salt is but little used. The sulphate of ammonia has the advantage of being the cheapest of the materials used for this purpose, and muslin dipped into a 10 per cent. solution of this salt, and then dried, is rendered quite non-inflammable. It is said, however, to interfere with certain colours, especially with madder purple. The best of all materials in the above list, however, is the tungstate of soda, for it possesses the property of being unaffected by ironing. All the other salts that have been mentioned are unable to stand the ironing process, and are therefore of very limited value. The majority, therefore, of non-inflammable muslins owe their properties to this little-known compound, tungstate of soda.

There are certain disadvantages in the use of these salts, the chief of which are these :—By the use of any of the above-named solutions the weight of the muslin is increased from 18 to 26 per cent., and as the salts are all soluble in water, they immediately wash out when under the hands of the laundress, and therefore the chemical treatment has to be repeated every time that the material is washed. To somewhat meet this latter difficulty a "a fire-proof starch," prepared with tungstate of soda, was introduced some years ago by Mr. Donald Nicoll. This starch, if used in the ordinary way, would render the fabric non-inflammable.*

A solution of molybdate of soda has been used for rendering non-inflammable the garments of workmen in arsenals, but I am unable to find any detailed account of its efficacy.†

It must not be supposed that these or any other chemicals prevent the fabric heated from being consumed if exposed to fire. They prevent it from breaking out into flame; and if a piece of "non-inflammable muslin" is set on fire it simply crumbles away in a manner that is comparatively innocuous. The only "cloth" that is absolutely unaffected by fire is "asbestos cloth." A coat made of this substance would merely be cleaned and improved by being occasionally placed in a furnace. Asbestos cloth, however, is rather a curiosity than a material for dress, although history informs us of several famous asbestos coats and cloaks. Probably the only specimens of this fabric will be found in museums and in the cabinets of the curious.

6. *Absorption of odours.*—"This partly depends on colour; and Stark's observations show that the power of absorption is in this order—black, blue, red, green, yellow, white. So far as texture is concerned, the absorption is in proportion to the hygroscopic absorption; and wool therefore absorbs more than cotton or linen."‡

7. *Electrical qualities.*—There is little to be said under this heading. It is well known that certain materials are better conductors of electricity than are others. Thus, as regards the commoner materials for dress, silk presents itself as a very bad conductor; and then in order of decrease come wool, flax, and cotton. With reference to certain other electrical qualities, Cerviotti places dress materials in two categories. (1) Idioelectric substances, or substances that are able to retain "animal" electricity—*e.g.*, silk, skins, etc. (2) Anelectric substances, represented by those that are able to disengage electricity by their friction, and to prevent its accumulation—*e.g.*, wool, linen, cotton.

8. *Certain poisonous dyes.*—Certain dress fabrics are obnoxious, in that they are coloured with poisonous dyes. The poisonous agent is usually arsenic, and the colours containing this agent are for the most part bright reds, magentas, aniline reds, and certain greens.

UNDERCLOTHING.

I now propose to consider the question of underclothing in its general features, reserving certain special details for further treatment.

Wool.—Without doubt wool is the best material for all kinds of underclothing, and there are very few circumstances under which wool is not the best material to be worn next to the skin. Upon these two points there is a remarkable uniformity of opinion among those who have the most fully considered the details of personal hygiene. The great value of woollen fabrics for underclothing, and especially for such clothing as comes in contact with the skin, will no doubt be understood from what has been already said. In cold weather woollen underclothing owes its so-called warmth to its remarkably poor conducting properties. These properties allow it to maintain the natural temperature of the body by preventing the heat of the body from being conducted away from the surface. It prevents, indeed, any loss of natural warmth. Linen and cotton materials, on the other hand, being comparatively good conductors of heat, allow the warmth of the body to be conducted away from the surface and by the loss of this warmth the surface becomes cooled. In hot weather, the poor conducting properties of wool are valuable in another way. It fails to conduct to the body the additional heat in the external atmosphere. It may be truly said to protect the organism from the heat by virtue of these non-conducting qualities. Cotton and linen, on the other hand, readily conduct to the skin the heat that is without, they serve as but the feeblest protection from that heat, and allow the body to be rapidly influenced by the condition of the external atmosphere. The great value of woollen underclothing, however, is shown by the manner in which it prevents or modifies the evil effects of rapid changes of temperature. In this country, at least, the climate is liable to certain abrupt fluctuations. A warm day succeeds a cool and a cool a warm with little notice or warning. The temperature that during the day has been high, may fall suddenly towards sunset, and a chilly evening succeed a blazing noon. It is needless, moreover, to say that like fluctuations of temperature occur at certain times and seasons all over the world.

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* See *Lancet*, vol. i., 1872, p. 875.

† See *Lancet*, vol. ii., 1867, p. 544.

‡ Parkes, loc. cit.

A good illustration of the changes of temperature to which the body may be subjected in a brief interval may be found on any warm day of early summer when a strong north or easterly wind is blowing. On such a day an individual sitting in the full blaze of the sun, and well sheltered from the wind, may feel positively "hot": while another, equally well protected from the wind, but sheltered also from the sun, may feel but comfortably warm; a third exposed to the full blast of the wind, to the rapid passage over the body of a colder air, may reasonably complain of being chilled. Now it so happens that the disorders that depend upon what is known as catching cold depend for the most part upon sudden changes of temperature. "These disorders," says an authority, "are induced by the removal of heat to an unusual extent from the external or internal surface of the body."* The same writer recognises three factors in the probable cause of a "cold"—a low temperature, air in motion, and moisture; and I think that common experience teaches us—*à propos* of these factors—that colds are most frequent when the weather is cold and windy and wet. Now, against these evils of sudden change woollen under-garments afford a trustworthy protection. They isolate the body. They prevent it from being influenced by the abrupt changes of temperature that are active around. Their properties are such that they become the poorest exponents of those changes. Linen and cotton, on the other hand, as good conductors of heat, are susceptible to modifications of temperature. They render the body injuriously *au courant* with the condition of the surrounding atmosphere, and would encourage it to take part in all the changes of temperature to which that atmosphere is susceptible. These, then, are among the reasons why it is recommended that at all times woollen materials should be worn next to the skin, and from these facts it will be understood why woollen underclothing is advised for those who visit the Arctic regions, while it forms the best material for under-dress for such as are exposed to the heat of the tropics.

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* Seitz. Ziemssen's "Cyclopædia of Medicine," vol. xvi., p. 232. 1877.

The body itself, moreover, is liable to certain modifications of temperature, which although slight in degree may yet be injurious in character, if abruptly brought about. I allude especially to the cooling of the body that is effected by the evaporation of moisture from its surface. Under certain circumstances this cooling may be excessive and abrupt, and as a result may arise disorders associated with catching cold. This matter is somewhat more concerned with bodily exercise than with external temperature, and its relations to the question of underclothing may now be noted. Let us suppose that two individuals undertake on a day in summer a similar exercise, the one being clad in woollen materials, the other in linen or cotton. If they are occupied in the open blaze of the sun, they will at the commencement experience about the same sensation of heat, provided that their garments are of the same colour; for it has been shown that colour rather than texture modifies the effects of direct solar rays. Shortly after commencing exertion, the man wearing wool next to his skin will feel warmer than the man wearing linen. The reason is this. Exercise increases the circulation of blood in the skin, and induces thereby a sensation of increased heat in the part. The woollen fabric by its rough surface would tend perhaps to irritate the skin, and by the friction induced by movement would probably still further encourage the circulation. There would be a trifling rise of temperature on the surface, and the skin would endeavour to cool itself by a copious perspiration. Now, the wool as a bad conductor would but tardily conduct away this new increment of heat, while at the same time its structure would cause evaporation of the sweat to be delayed and slow. The individual therefore would not at once experience the cooling effects of natural evaporation. In the case of the man wearing linen, he would feel less warm than his fellow, because the heat of the body would be rapidly conducted away, and the evaporation from the surface would be free, because the linen fabric would soon become wet, and by adhering to the body would still further favour the evaporating process. In process of time, however, the evaporation in the case of the individual clad in wool would be better established, the sensation of heat would be less marked, and the one man would feel as warm, or as cool, as the other.

Now, suppose that they both suddenly cease from their exertions, and rest surrounded by the same conditions. In the individual wearing linen next the skin the evaporating process will—for reasons already given—be vigorous, and its cooling effects coming with the cessation of exercise will be somewhat sudden. A great deal of heat will be rapidly removed from the body, and the condition necessary for catching cold will be established. In the case of the man clad in woollen materials, the evaporation will proceed leisurely; the properties of the wool with regard to heat would tend to prevent a sudden loss of animal warmth, and the body would cool slowly. It is needless, therefore, to point out that woollen underclothing has overwhelming advantages, and that wool is, of all materials, the best suited for the varying circumstances of human life. One might conclude, therefore, by saying that underclothing should be of wool, and that that material should be worn next the skin, while under no ordinary circumstances should linen be worn next the skin. It is, perhaps, needless to add that the thickness and density of the fabric worn must be influenced by the climate and season of the year.

Objections to Woollen Underclothing.

The chief objections urged against woollen fabrics as materials for under garments are, I believe, the following : (1) They are heavy ; (2) they often irritate the skin; (3) they are less cleanly than linen. (1) With regard to the first objection, it may at once be stated that for an equal weight, wool is the warmest material available for dress. A woollen shirt will be infinitely warmer than a linen shirt having the same weight. This may be allowed for winter attire, while it is urged that by wearing woollen fabrics in summer unnecessary weight is carried. But then it must be remembered that in the summer woollen materials of quite unnecessary thickness are often worn, and thus possibly a bias against such garments has arisen. As a matter of fact, the body can be properly clad with less amount of weight by wool than by any other material, and those who complain of the weight of woollen garments in summer have not yet found out a material thin enough or light enough for its purpose. The matter will again be alluded to when speaking of woollen gauze underclothing. (2) It is perfectly true that woollen or flannel materials do often irritate the skin, and that that irritation is, in some cases, such as to interfere with their being worn. These irritating properties depend upon the roughness or coarseness of the material, and are directly due to innumerable minute filaments that project from the surface. The therapeutic value of flannel depends to no small extent upon its power of stimulating the skin. It is this power that makes it popular with the old, and with those whose circulation is sluggish. Amongst the poor, a common remedy for rheumatic and other pains consists in the application of a piece of new flannel to the part; the feeble efficacy of this treatment depends, I imagine, to some extent, upon the irritating effect of fresh flannel upon the skin. It is, indeed, in such cases a "counter-irritant." A French writer has ascribed a multitude of evils to the wearing of flannel next the skin. He gives cases of neuralgia and of various skin irritations that he maintains were caused by wearing flannel, and details an instance of sleeplessness that was ascribed—apparently with some truth—to the wearing of a flannel night-dress. In the great majority of cases the skin becomes accustomed to the irritation caused by woollen garments, and the stimulation of the skin that such garments promote adds then merely to the sense of comfort. For the old, the delicate, the scrofulous, and the rheumatic, flannel under-garments are especially desirable, and in such individuals complaint is seldom made of undue cutaneous irritation. But wool is worked up into other fabrics than flannel, and those who find this stuff uncomfortable should wear "merino" garments, or adopt the finer kinds of wool. Wool can, indeed, be woven in such a manner as to have a surface almost as soft and non-irritating as the surface of silk. In hot weather, particularly rough woollen garments are apt to be uncomfortable, and should be replaced by those finer and thinner materials that are alone suitable for use in summer. Silk has properties as a dress material that are but little inferior to those possessed by wool, and in instances where wool does cause much irritation silk may well be worn next to the skin. By those who cannot well adopt this alternative, a "lattice-work," or gauze under garment may be worn; and this, although made of cotton, does not have the injurious effect of a cotton garment, as it actually covers but a fractional part of the surface. Over such a garment woollen materials may be worn without discomfort. (3) Woollen materials absorb moisture freely, and when that moisture takes the form of perspiration from the body, its retention in the garment is not desirable for long. Unfortunately, woollen fabrics soil less readily than do linen structures, or rather, show less quickly the outward and visible signs of dirt. It thus happens that amongst the poor woollen underclothing is often worn without change for alarming periods of time. It is needless to say that this gross practice of uncleanliness is injurious, and doubly so because woollen fabrics are particularly adapted for the accumulation and nourishment of those animal parasites that follow in the wake of filth. A woollen garment worn next to the skin should be changed as often, or nearly as often, as a like garment made of linen; and as the labouring classes are not likely to adopt this advice, it must be owned that on the score of cleanliness wool has decided disadvantages. With the well-to-do this objection does not, or should not, hold, although it must be confessed that even educated people have often very crude notions as to what constitutes personal cleanliness.

General Facts in Connection with Underclothing.

(1) *Loose-fitting clothing is—other things being equal—warmer than tight-fitting.*—A woollen shirt, or under-vest, made quite loose will be much warmer than a like garment made of the same material, and of precisely the same thickness and texture, but so constructed as to fit the body quite tightly. In the case of the close-fitting garment, the material is kept in direct contact with the skin, and is therefore able the more readily to conduct away the heat of the body. In the case of the loose-fitting garment, there is a more or less constant stratum of air between the integument and the article of dress, and this stratum of warm air has an important influence on the bodily heat. Air, it must be remembered, is a very bad conductor of heat, and this stratum of air next to the skin acts almost in the same way as an additional garment. It is interposed as a non-conducting medium between the surface of the body and the external atmosphere.

(2) *A material loosely woven is warmer than the same material closely woven.*—Thus wool or cotton, when carded and spread out as wadding, is warmer than would be the same quantity of material when spun into cloth. This depends upon the fact, already stated, that air is a bad conductor of heat, and the loose material, by confining air within its meshes, adds materially to its warming properties. At the

same time, it must be remembered that a very dense fabric—such, for example, as fine and closely-woven flannel—is peculiarly warm as an article for clothing, because its density interferes with the evaporation from the skin on the one hand, and prevents the penetration of cold winds on the other. Recently a material has been introduced for underclothing that consists of wool, cotton, or silk, made up into a kind of netting or lattice-work. It may be difficult at first to understand how a fabric so scanty that it has little more material in it than a fisherman's net could afford warmth to the body. But this substance allows a large stratum of warm air to be kept in contact with the body, and to this stratum its main value as a garment is owing. The fabric also allows of a free and normal action of the skin, and favours the maintenance of an equable temperature about the parts that it covers.

(3) *Clothing worn in successive layers is warmer than the same amount of material in a single layer.*—That is to say, two shirts, or other garments, worn the one over the other, will afford more warmth to the body than would a single shirt containing the same amount of material as is required for the two garments. The truth of this statement can be appreciated by noting what has been already said respecting the non-conducting properties of air. Moreover, garments in layers would offer more resistance to the penetration of cold winds and less support to the process of evaporation than would a single garment containing an equal amount of material.

(4) *Underclothing should be light and porous*, and free from any ornamentation that would add very materially to its weight. It should be permeable to air, for the reasons that have already been fully detailed. Thus it will be seen that very fine materials, such as very densely woven flannel, are often open to objection.

Night Attire.

The above remarks apply to clothing worn during the active part of the twenty-four hours. A night-dress should be of linen or cotton. Such a material is advisable, inasmuch as it gives rest to a skin that may have been unduly stimulated by woollen undergarments during the day. It is, moreover, worn under conditions that favour inactivity of the functions of the skin, and is therefore little concerned in the process of evaporation. While in bed, the body depends for its warmth upon the bed-clothes, that, as a rule, are represented by a considerable amount of woollen material or down. The night-dress, therefore, fulfils the requirements of cleanliness and personal comfort rather than the primary needs of dress. While in bed, moreover, the body is surrounded by a considerable amount of warm air. Under ordinary circumstances, in this climate at least, the use of woollen fabrics for night clothing is to be condemned. Such garments may not afford to the skin a needed rest. They may promote perspiration under circumstances when it is neither desirable nor controlled by ready evaporation. They may maintain the body at an unnecessarily high temperature, and they may tend to the neglect of proper cleanliness. By quite young children, and by the old, where the animal heat is but feebly maintained, such garments may be worn in addition to the linen dress. They may also be advisable for the rheumatic, and in certain forms of delicate health and of disease; and they may be absolutely necessary in very cold climates.

MALE DRESS.

The Head.—The natural coverings of the head, and the peculiarities of the structures within the skull, are such that the matter of dress as applied to this part requires to be discussed upon peculiar grounds. In the first place, the scalp is dense and thick, and is more freely supplied with blood than is any other part of the skin of like extent. The liberal circulation of warm blood through the scalp enables its temperature to be well maintained, and renders it to some extent independent of those fluctuations of temperature that exist without. The hair, moreover, forms a natural covering or dress for the head, and being a bad conductor of heat, it possesses, when tolerably thick, many of the valuable attributes of a woollen garment. Within the skull is the brain. Owing to the density of the scalp, the thickness of the skull-bones, and the many layers of different tissue that intervene between the outer world and the brain, this organ is not readily affected by external modifications of temperature. If the head is exposed to chilling influences, the individual may catch a cold, but he is not likely to develop a headache. The ill effects of the chill, it would appear, do not penetrate to the brain, although cases are noted where inflammation of the brain or its membranes has followed, or been supposed to follow, upon exposure to cold. Such cases, however, must be quite infrequent. Heat has a somewhat less superficial effect, and an exposure of the imperfectly covered head to intense solar heat may lead to the brain disorder known as sun-stroke.

The head, moreover, seems peculiarly susceptible to even slight degrees of heat. If the head be rendered unduly warm by a thick or heavy hat, a sense of discomfort is soon experienced, which is perhaps more marked than are like sensations in other parts. There would appear to be a generally expressed desire that the head should be kept cool, and in warm or moderately warm weather there are few things more refreshing than a temporary artificial cooling of the scalp. The brain, like the outer covering of the skull, is very liberally supplied with blood, and its circulation is readily influenced by an exercise of the function of the organ. During mental exertion or mental excitement, an unusual quantity of blood is brought to the brain by its blood-vessels. A sense of heat and fulness in the head, with possibly headache, may follow. Now, there are communications between the blood-vessels within and those without the skull, and by diminishing the circulation in the latter, relief is given, to some extent, to an engorged condition of the former. Thus, cold to the scalp may relieve the discomfort felt during or after severe brain work, while, on the other hand, additional warmth to the scalp would certainly add to that discomfort. We hear of students adopting the somewhat questionable practice of reading with a wet handkerchief round their heads, and there is no doubt that this practice would more readily modify any discomfort that may attend prolonged brain work than would the practice of studying in a heavy black hat. It must be remembered that the skull is unyielding, and that an addition of material to the parts within the skull would soon be felt, even if that addition is merely represented by a little extra blood. These and other facts may serve to explain the *rationale* of the popular advice to keep the head cool.

In studying the history of the development of dress, it would appear that the hat was somewhat late in appearing upon the scene, and that the head was among the last parts of the body to be covered. There are millions of individuals at this present time in the world who from birth to death wear no covering for the head. It may indeed, with some reservation, be said that, of all parts of the body, the head is the part the least needing to be covered. It has, in truth, a good natural covering of its own. This covering, although it meets with all the requirements of simple savage life, does not fulfil all the needs and the artificial conditions that arise out of a civilised existence. Thus, hats become a necessity. The dense "wool" on the negro's head affords an admirable covering. It is light; it is a bad conductor of heat; its arrangement is such that its interstices are occupied with air; it affords, for a while at least, a protection against rain, and, even when quite wet, is able to completely annul the possible ill effects of much moisture in contact with the skin; it is not quite innocent of grease, and the admixture of oily matter adds to its property as a feeble conductor of heat; it defies the sun, and by its denseness and elasticity affords no mean protection from external violence. As far as the needs of health are concerned, the wearing of a hat by an individual with so good a head covering as the negro possesses is a pure work of supererogation.

On the other hand, the thinner the layer of hair the greater is the need of some artificial covering for the head, and for a bald man such a protection becomes an absolute necessity. It would appear that as civilisation advances the hair becomes somewhat scantier and less robust. I imagine that, in the matter of hair, the heads of the people of this country at the present day would not compare well with the heads of the ancient Britons, of whose dense and matted locks history gives some account. I think especially that the prevalence of early baldness may not unreasonably be ascribed to certain conditions incident to civilisation.

Before coming to the subject of hats, one word may be said as to the practice of saturating the hair with oil or grease. This dirty and offensive habit—which is probably less common than it was—is the relict of the savage taste for soaking the hair with fatty matter. It is, I believe, in Abyssinia that certain natives delight to obtain a mass of grease, which they place on the head under the cover of a leaf. As the fat melts, it soaks well the hair, and then runs down over the neck, shoulders, and trunk. The pleasure derived from this pursuit may depend upon the glistening effect produced by oiled surfaces, but I imagine that it is mainly due to the additional comfort that the layer of so bad a heat conductor as oil gives to the body. This latter property of oil may serve to explain its original use when applied to the hair. There is normally supplied by the scalp a quantity of oily matter sufficient to maintain the hair in good condition, and there appears to be no excuse for the custom of soaking the hair with a material that decomposes and becomes rancid, and favours the accumulation of dirt and the fostering of parasites.

Hats.—The object of a hat is to protect the head from undue cold in the winter and from undue heat in the summer, to protect it from rain, to offer some shield to external violence, and some opportunities possibly for adornment.

It is doubtful if any one kind of hat would meet perfectly and equally all these requirements at once. It is particularly necessary that any hat worn should be *light* and *well ventilated.* A heavy hat presses with undue weight upon the scalp. It produces by that weight a sense of oppression and constriction. It may somewhat diminish the blood supply of the scalp by pressing upon the vessels that nourish it. Lastly, it is apt to injuriously press upon the nerves of the part, and so produce headache and neuralgia. It is asserted, moreover, on what I think are probable grounds, that the long continued wearing of heavy hats tends to produce baldness. With regard to the actual weight of certain hats, it may be interesting to note that the ordinary tall black hat weighs from 5 to 7 ozs., the infantry shako, according to Parkes, weighs 9¾ ozs., the engineer's busby 13½ ozs., the lancer's cap 24½ ozs., and the "bearskin" 37 ozs. The last item is significant if it be borne in mind that a proper covering for the head can be obtained from material weighing, let us say, 3 ozs., so that in the "bearskin" ornament and perhaps protection from violence are represented by no less than 34 ozs. In designing the "bearskin," health must have been represented by the figure 1, adornment by the figure 10.

In the next place, a hat, whether light or heavy, must be well ventilated. The scalp perspires as does the rest of the skin. In a badly ventilated hat, the air within the hat and in contact with the head soon becomes fully charged with moisture, evaporation is in abeyance, the perspiration collects in visible amount, and the natural means for cooling the surface of the part is destroyed. Thus a badly ventilated hat soon produces a sense of heat and oppression. The wearer feels constrained to lift it from his head whenever he can, and if only for a moment. By such means alone can he bring a dryer air in contact with the scalp, and so re-establish the normal process of evaporation. Thus it happens that a non-ventilated hat is very apt to produce a cold, owing to the sudden fluctuations of temperature to which the head may be exposed. For when the hat is on, the part will be unduly warm ; when suddenly taken off, its temperature will tend to fall abruptly, owing to the removal of heat by evaporation.

It is absurd to suppose that a hat can be ventilated by a few holes being punched here and there. The partly occluded aperture in the crown of most tall hats is a singular burlesque on the needs of ventilation, and is, of course, perfectly useless. A hat that aims to be properly ventilated should permit of a current of air through its interior when it is fixed upon the head. There should be an aperture in the crown through which the air heated by contact with the scalp could escape, and apertures about the brim of the hat by which fresh air could enter. Several hats fulfil these conditions by means more or less ingenious, although it would appear difficult to fully attain these ends without visibly increasing the dimensions of the head covering.

To protect the head against *cold*, the covering should be made of some feeble heat-conducting material, should be light, well ventilated, and of dark colour. Thus, I think that the best hat for winter in this country is one made of felt or dense woollen cloth dyed black, free from rigidity and properly ventilated. To meet extreme cold, the fur cap worn by Arctic travellers fulfils its purpose well. The fur is a poor heat conductor, while the skin to which it is attached serves as a good protection against penetrating winds. Owing to the inactivity of the skin in an atmosphere of extreme cold, the ventilation of such a cap is practically a matter of no importance.

As a protection against solar *heat*, the head-dress should be light in colour, or, if possible, quite white. It should be perfectly ventilated, and free from even a fraction of unnecessary weight. It should possess either a broad brim or be of helmet shape, so that it may afford some protection to the face and back of the neck. For the summer in this country no head covering could be better than a common white straw hat, provided that its texture be loose enough and coarse enough to allow of a free passage of air through all its parts.

For hotter climates—as, for example, for India—a somewhat more elaborate head covering is required. "The head-dress, to be effective," says one writer, "should possess such resisting powers as to ward off entirely the whole rays of the sun throughout an exposure to its action of any duration, and not only from the skull, but also from the sides of the head, face, and neck. It ought also to transmit so copious a ventilation over the head as to encourage the perspiration to evaporate freely from it. At the same time, such a head-dress should be no more cumbrous than is necessary to fulfil all these conditions completely."* The head-dresses most strongly advised for wear in India are made of pith or bamboo wicker-work, and are covered with white cotton (Parkes). Especial arrangements are made for the perfect ventilation of the interior, and the whole structure is extremely light. For many reasons, the helmet shape is the best that can be adopted, and its outline is peculiarly favourable to proper arrangements for ventilation. It may be well to note that "sun-stroke," or "heat-stroke," does not of necessity depend upon the direct action of solar rays. Sun-stroke may, indeed, occur when the sun is not shining, and at least one writer upon the subject has asserted that "the direct influence of the sun has nothing whatever to do with its production."† The symptoms of sun-stroke would appear to be due to many causes, all of which are dependent upon an abnormal increase in the temperature of the body. It is well known how the occurrence of the malady is favoured by violent exercise during periods of extreme heat, and much stress has been laid upon a diminished activity of the heart's action as an essential feature in this disease. It is, however, very certain that the liability to sun-stroke is greatly diminished by a proper head covering, although it must not be concluded that sun-stroke cannot occur when such a head-dress is worn.

In the matter of particular head coverings, the ordinary tall black hat possesses perhaps the greatest number of bad points and disadvantages.

It is heavier than a hat need be, it is rigid, it is impervious to moisture, it compresses the scalp in an unyielding line, and usually presents no opportunities for ventilation. To these disadvantages it adds the feature of being peculiarly ugly. This hat, moreover, is worn both in cold weather and in hot, and is particularly affected by those who may reasonably be supposed to be desirous of "keeping their heads cool." This eccentricity in modern dress is bad enough when worn in winter, but as a covering for the head during the height of summer it could hardly be more unsuitable.

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* "The British Army in India." By J. Jeffreys. London, 1858.

† Nothnagel. Ziemssen's "Cyclopædia of Medicine," vol. xii., page 43. London, 1877.

The soft black felt hats worn by certain clergymen and others are good head coverings for the winter, but in the hot seasons of the year they are objectionable by reason of their colour and their density of structure. The skull-cap and the fez have drawbacks in that they closely embrace the head, and are usually of so close a texture as to prevent the escape of the moisture from the skin. The straw hat favoured by the boating world, and by those "who go down to the sea in ships," as well as the light white cap of the cricketer, are sensible and suitable for reasons already given. The black and heavy helmets of the police force must be mild means of torture during the dog days and in the "baking streets." The head gear of the army is open to many objections on the ground of health, although at the present time its evils are lessened by the modifications it undergoes when the wearer is subjected to extremes of climate. Lastly, the college cap, or "mortar-board," while tolerated out of respect to ancient custom, is an offence against the laws of health by its weight, its uniform black hue, and its scanty provisions for ventilation.

To what extent the robust, and especially those who are both robust and young, can dispense with head coverings altogether is illustrated by the pupils of Christ's Hospital. They appear to suffer no inconvenience from their peculiar attire, although some protection for the head is considered necessary when they are exposed to the heat of the sun in summer. Some thousands of street Arabs in the Great City thrive—so far as such mortals can thrive—with no covering for the head but a mat of dirty hair; and it is not uncommon in the country to see men and women labouring in the fields with no head-dress other than that provided by nature.

And now as to the covering of the head at night: a man might as well sleep in his boots as seek repose in a night-cap. With but very few exceptions, this article of dress is entirely superfluous, even when not injurious. During the night the scalp has an opportunity of recovering itself from any evils that continued hat-wearing may have brought about, and that opportunity should be seized. In the time of wigs, a night-cap was not only excusable, but even essential, to prevent too sudden a change of temperature, incident upon the removal of a heavy mass of false hair. For certain delicate individuals at the present day such a head-covering may be necessary. It may be of benefit also to the old, to the rheumatic, and certainly to the bald. But for the majority of individuals the night-cap is no more an essential to health than it is a contribution to personal beauty.

The Neck.—The neck contains many structures of importance. In it run the great blood-vessels (the carotids) that supply the face, head, and brain, and the great veins (the jugulars) that return the blood from those parts. In the middle line is situated the larynx, or organ of voice, and also the trachea, or wind-pipe. Behind these structures is placed the gullet. At the sides of the pharynx, or upper part of the gullet, the tonsils are located, and beneath the skin of the neck are clustered a number of lymphatic glands that are apt to become enlarged and inflamed under certain circumstances.

In discussing the question of dress as applied to this part of the body, it is necessary to consider (1) the advisability of constricting the neck on the one hand, or of allowing it free movement on the other, and (2) the importance of entirely covering up the part, or of leaving it unprotected by clothing. 1. The neck is susceptible to many and frequent movements. Its proportions are altered in nearly every motion of the head. During the acts of deglutition and vocalisation its outline undergoes a visible modification. It is indeed a part seldom left at rest. Any constriction would seriously hamper these movements, and tend to interfere with the functions to which they administer. Constriction, moreover, has some effect upon the blood-vessels of the part. It may lead to more or less compression of the veins that are bringing the blood from the brain and head, and thus induce some congestion of the parts whence these vessels have issued. The neck, therefore, should be so clothed that all its movements and the changes in its proportions remain unhampered. Stiff stocks and high collars, that reduce the neck of man to the condition of the neck of a plaster figure are in many ways obnoxious. Equally objectionable are tight scarves, neckcloths, or collars. They interfere with more than one important function, and are apt to hamper the blood circulation. For this latter reason, any constriction of the neck by an article of dress is peculiarly objectionable in the plethoric and in those whom the laity denominate "apoplectic." Perhaps the evils inflicted by tight scarves, &c., upon these individuals have been exaggerated, but their possibility can certainly not be ignored. 2. The question as to whether the neck should be entirely covered up, or left more or less unprotected, must be settled rather by an appeal to individual cases than to general principles. As a rule, it should be but slightly and but partially covered. Indeed, during warm weather and when in the house, the less the neck is protected by clothing the better. A scanty amount of clothing about the neck allows of an opportunity for ventilating the surface of the trunk (if such an expression may be used) and allows all movements to be unimpeded. In very cold weather, and in delicate individuals, it is, needful, of course, that this part of the body should be well and warmly clad. Custom has great influence upon this matter. The sailor, whose neck is somewhat obtrusively bare, is no more liable to affections of the part than is the soldier, in whom the neck is, perhaps, too entirely protected by clothing. I can imagine that if the sailor were suddenly to adopt the neck costume of the soldier, or the soldier that of the sailor, some inconveniences might arise. These evils would serve to illustrate the fact that the body resents abrupt changes, while it tolerates those that are of slow development.

On the whole, and so far as the climate of this country is concerned, the manner in which the neck is clad at the present day would appear to be well in accord with the dictates of health. It avoids the extremes of the Byronic attire on the one hand, and the extensive neck-dress worn about the time of the French Revolution on the other.

The Trunk and Extremities.—In the matter of male attire as applied to the trunk and extremities little need be added to what has already been stated in dealing with the comparative value of certain dress materials and the subject of underclothing. The outer garment should conform to those rules that are dictated by a consideration of the primary purposes of clothing, and should aim at properly protecting the body, and at maintaining it everywhere at an equable temperature. These garments should be so constructed as to avoid compression of any part, and should be free from superfluous weight. With regard to this latter point, it is difficult to give sound data without at the same time entering into many and needlessly-minute details. It is possible, however, to appreciate the weight of clothing worn by those whose costumes are uniform and liable to but slight modification from time to time. As examples of such, we may take the dress of soldiers and sailors. According to Dr. Parkes, the weight of clothing worn on the person of an infantry soldier amounts to about 10 lbs., this estimate including the shako, winter trousers, and leggings. The infantry great coat weighs on an average from 5 lbs. to 6 lbs. Dr. Buck gives 9 lbs. as the average weight of the clothing usually worn by sailors, and 13 lbs. 8 ozs. as the weight of the entire suit, including the overcoat, cap, and shoes.

Recapitulating what has been already stated, it may be said that woollen outer garments should be worn in cold weather; while in summer the material is—other things being equal—of less importance than colour, and in hot weather the best outer garment is one made of cotton or of like substance, either white or of light colour. Garments worn in successive layers are warmer than a single garment containing the material of many. The dress fabric should be porous within reasonable limits, and should not be worn too tightly applied to the body. It must not be supposed—as some would appear to believe—that one simple garment is equally well adapted for both hot weather and for cold. In this country, among a certain class of men, one uniform black coat is worn throughout the year, quite irrespective of changes of temperature and climate. The laws of society are opposed to the indiscriminate use of healthy dress; and in selecting attire there are many who must conform to social dictates before they can attend to the demands of health. To a professional man a black frock coat may be a suitable-enough garment for an English winter, but the usages of society would not tolerate the spectacle of a physician visiting his patients in the summer clad in white cotton trousers and a cotton blouse, with a white straw hat, and a neck innocent of collar or scarf.

Trousers should be suspended from the shoulders by means of braces. Belts and waistbands of all kinds are objectionable. They involve more or less constriction of a part that is often seriously affected by constriction, and that especially requires freedom of movement. In men the outline of the body is such that there is but an insignificant amount of waist, and the hips when compared with those of women are not prominent. The practice of bracing a belt tightly round the waist when about to commence vigorous exercise is particularly objectionable, and may lead—as one writer has pointed out—to the development of rupture. Braces should be of elastic rather than of non-elastic material, in order that they may conform more readily to changes in the posture of the body. The braces commonly used to suspend the nether garments are objectionable in that they involve, in to and fro movements of the body, a considerable amount of friction, and some slight amount of strain upon the shoulders. This objection would be met by a brace so constructed that the part crossing the shoulders would remain unmoved during changes in the posture of the body, while the necessary movement was thrown upon that part of the brace that is attached to the trousers.

Tight leathern breeches are injurious in that they interfere with muscular movement, and hamper the proper exercise of the muscles, while at the same time they harass the surface circulation of the limb, and are apt to make the thigh cold and often numb. These evils are intensified when the garment is not only too closely applied to the extremities, but serves to constrict also the region of the groin.

Dress as applied to the *Hands* and *Feet* will be discussed in dealing with the subject of women's dress.

Female Dress.

The Head and Neck.—The general circumstances that influence the proper clothing of the head and neck have been already considered. It remains to take note of some few points that are especial to women in connection with these regions. If the male head actually requires but little covering, the female head is certainly in need of still less. In the first place, women are provided with a more dense and abundant covering of hair than men can boast of, and it is possible for that hair to be so arranged about the head as to discharge nearly all the functions of a perfect hat. There is, or was, for example, a fashion of "doing" the hair that consisted in forming it into several plaits, that were then lightly coiled around the head so as to evenly cover it over the greater part of its extent. By this means the head was provided with a natural cap, made of a material that of all others would appear to be the most suitable as a covering for it, that was light, easily penetrated by air, pervious to moisture, and not readily influenced by change of temperature. In ancient Greece the hair appears to have been so worn as to render the head, under ordinary circumstances, independent of artificial protection. This was effected by keeping it moderately short, and by massing it more or less evenly over the head. The hair was thus kept loose, and the scalp free from unnecessary compression. As one other example may be noted the fashion of wearing the hair short, and of splitting it up into a thousand small curls that evenly covered the head with a light but efficient covering. In such a method the scalp is protected by means that find their most complete fulfilment in the woolly head of the negro.

In the next place, women are much less exposed to the vagaries of climate than are men. They are not (or should not be) exposed to a scorching sun for many hours while engaged in some laborious work, nor, under ordinary circumstances, are they required to battle with wind and rain; their life is such that it is spent rather under shelter than in the open, and even their outdoor amusements do not usually call for much intimate acquaintance with the "elements."

Lastly, the parasol must be regarded as a kind of hat. I would not for a moment advocate the use of this *impedimentum.* But its adoption is very general, and it may fairly be considered as affording a covering for the head. The thickness of the hair and the excellent blood supply of the scalp afford substantial protection against cold, but against solar heat the civilised female requires artificial aid. The parasol is certainly not the best means of affording that assistance. It has to be supported over the head, and is one of the many little obstacles in the way of an easy and graceful carriage. That women can without detriment go with the head practically bare—if we exempt the umbrella and sunshade as head-gear—was, I imagine, practically demonstrated some years ago, when the bonnet was reduced to such microscopic dimensions that by no stretch of language could it be said to have covered the head.

Whatever artificial covering is adopted for the female head, it should at least have these qualifications :—It should be light, and pervious to air and moisture. It should maintain the head at all parts at an equable temperature. It should not constrict the scalp, and it should be competent to protect the eyes from the glare of the sun. There is a tendency, perhaps, in women, to carry too much rather than too little upon the head. Considering the hair as a head covering, it is often most indiscreetly used. It is allowed to grow too long, and to oppress the head by its needless weight; or it is massed into knobs and protuberances, that leave one part of the scalp almost bare and another part unduly covered up; or the abomination of false hair is indulged in, and collections of this material are located upon the scalp in spots indicated by fashion, with the result that undue pressure is brought to bear upon the skin, and the temperature of the head is disturbed, and rendered unequal. Apart from this, there are details associated with false hair which are not at all pleasant to contemplate.

With reference to *bonnets*, they are often rendered unduly heavy by superfluous ornament, even if not of much weight in themselves. Bonnets and hats, moreover, are frequently poised on one segment of the head only. They have been worn, located at the back of the head, so as to leave a considerable portion of the vault quite bare; and have, on the other hand, been worn so far forward as to approach the eye-brows. Bonnets should, if possible, protect the eyes from the glare of the sun. At present this protection is afforded by the parasol, which is tolerated because just now it is unfashionable to exhibit upon the cheeks the signs of health. The edicts of fashion assert that the complexion must be "preserved," a sickly pallor is more to be desired than a ruddy skin, and there is some vulgarity surrounding the "nut-brown maid." So long, therefore, as the natural effects of sunlight and a freshening breeze upon the healthy cheek are vulgar, so long will parasols be a necessity. When, however, the popular taste will allow that there are beauties in health as well as in disease, the sunshade may be cast aside, the face may be freshened by sun and wind, and a bonnet may be worn so constructed as to shade the eyes from glare.

One word with regard to *veils*. They are worn, I am told, for many reasons. They keep the hair from being blown about; they help to maintain a bonnet in its place; and they serve to hide a coarse skin, and to modify the effect of a spotty complexion. It is for others to judge whether these objects are sufficiently weighty to countenance an article of dress that must under any circumstances be uncomfortable. I do not for one moment believe the statements that have been advanced to the effect that veils cause short-sightedness, squinting, and blindness,* although they must interfere a little with vision when worn.

When carried over the mouth, they soon become saturated with moisture, and thereby cause all the air that is inhaled to be unduly charged with dampness. This can scarcely be other than a disadvantage. The veils thus moistened, moreover, may in cold weather lead to chapping of the skin and to cracked lips, and, by means of the poisonous dyes that they sometimes contain, may induce certain conspicuous eruptions of the face.

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* "Dress and Health." Montreal, 1880. Page 75.

The Neck.—The observations that have been already made upon the clothing of the neck in males apply equally to the opposite sex. But few especial points have to be noticed. Perhaps the most common fault observed in the neck clothing of women consists in the frequent changes that are effected in the amount of material worn round the part at various times. At one period of the day the neck may be well covered up to the chin, while at another period (as, for example, when an evening dress is donned) it may be suddenly left absolutely bare. To keep the neck *constantly* well protected by clothing may not be an evil, nor may it be injurious to leave it *constantly* entirely bare, but it certainly is an evil at one time to protect the part elaborately, and at another to leave it free from all covering. Sudden fluctuations in the circulation and temperature of the skin are not well borne in any part of the body, and the neck forms no exception to the rule. As to what may be the actual manifestations of this unwise practice, it is perhaps difficult to speak with precision. I think it will, however, be allowed that women are more prone than men to sore throats, to colds, to mild attacks of laryngitis, associated with some loss of voice, and to swellings of the lymphatic glands in the neck. It may not be incorrect to assume that these evils are often to be traced to the uncertain covering of the female neck, and to the abrupt fluctuations of temperature to which that part is sometimes exposed. Women, perhaps, indulge more frequently than men in the practice of wearing tight collars and bands around the neck. This practice appears to be less common since the admiration for a "swan-like neck" has waned, and since it has been demonstrated that such a neck is generally the outcome of an undesirable degree of emaciation.

Dr. Vaughan, in his remarkable essay on dress, observes that "three times in his life he has seen them (collars) so tight as to break while the ladies who wore them were dancing."* These accidents are certainly less common at the present day, but at the same time it is desirable to remember that any constriction of the neck, however slight, cannot be other than injurious.

The Trunk and Extremities.—Under this heading, which practically involves the consideration of the whole attire of women, a great deal has to be said. It must be confessed that the dress of women at the present day is in many points extremely bad, that it is as a whole unreasonable, and in many details purposeless, and that it tends to be injurious to health, and to interfere with the proper functions and development of the body. Much—possibly too much—has been said of late upon the evils, both real and imaginary—of the female attire of the present day and vigorous reforms have been instituted for its improvement. These attempts at a dress reformation have been—like other reforms—often violent and premature. They have been ushered in with exaggerated statements as to the evils of modern dress on the one hand, and the benefit of some "hygienic costume" on the other, and not a little has been done to delay the progress of a sound reform by the extreme action of the apostles of change. It is necessary, therefore, in dealing with this matter, to proceed with caution, and upon the lines only of simple fact, avoiding extremes, and especially the hysterical utterances of the alarmist, and taking into some consideration existing tastes and what may be fairly considered as existing interests.

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* "An Essay, Philosophical and Medical, concerning Modern Clothing." London, 1792. Page 54.

I propose to first point out the defects and evils in the female attire of the present day, and then to indicate the manner in which those evils may be remedied, and the lines upon which a healthier form of dress may be constructed.

Underclothing.—Before attempting any criticism upon this matter, it is well to bear in mind the requirements of healthy dress. They are, the perfect covering of the body, the maintenance in all parts of an equable temperature, the absence of superfluous material and needless weight, and the non-interference with any of the normal functions of the organism.

In the first place, the material worn next to the skin by perhaps the majority of women is either linen or cotton. The total unsuitability of such materials for underclothing has been already pointed out. It is true that women are not commonly exposed to such extremes of temperature as men often endure, but at the same time they are probably more susceptible to fluctuations of temperature, and more liable to suffer injury from such changes. It is very desirable, therefore, for reasons that have been already given, that woollen fabrics should replace those now so commonly worn next to the skin. In the summer, and by those persons whose skins are unduly irritable, a silken material or a gauze fabric may be worn in contact with the body, but there are no ordinary circumstances that render linen under-garments either desirable or likely to be free from injurious effects.

The ordinary linen or cotton garment that is almost universally worn over the trunk, is in many respects a ridiculous article of dress. It leaves the neck and upper half of the chest bare, and, being sleeveless, it affords no covering for the arms. It is, moreover, needlessly loose, and instead of fitting the body and clothing it evenly, it becomes thrown into folds about the waist, that add to its unequal properties as a maintainer of the warmth of the body. As an article of dress, therefore, it is very defective, and somewhat purposeless, and involves an expenditure of material out of proportion to its value as an element of healthy clothing.

Referring more generally to the unequal distribution of warmth that women's dress encourages, it must be noted that in the case of a female clad in the ordinary way, the character and arrangement of her garments are such that the body is found to be most unevenly covered, and that certain parts are kept unduly warm, while others are allowed to become unnecessarily cold. *A propos* of this matter, it is, perhaps, needless to refer to the *low-necked dress.* This costume has been so extensively and so systematically abused that further condemnation of it may be unnecessary. Certainly, few forms of attire could exhibit more glaring errors, or be less consistent with the requirements of health.

To come, however, to every-day attire: the condition of a woman clad as the great majority of the sex are clad, is thus graphically described by an American lady* who has written much on dress:—"The limbs have not half the amount of covering which is put upon the trunk of the body. Many garments have no sleeves, and what sleeves there are either come to an end a few inches below the shoulder, or they are loose and flowing at the wrists, so as to expose the arm as far as the elbow to the cold air. As to the legs, the clothing, which should increase in direct ratio to the distance from the body to the feet, diminishes in the same ratio. Thin drawers, thinner stockings, and wind-blown skirts which keep up constant currents of air, supply little warmth to the limbs beneath. The feet, half clad and pinched in tight boots, are chilled in consequence. The trunk of the body has as many varied zones of temperature as the planet it inhabits. Its frigid zone is above, on the shoulders and chest; for, although the dress-body extends from the neck to the waist, most, if not all, of the garments worn beneath it are low-necked. The temperate zone lies between the shoulders and the belt, for that region receives the additional covering of under-vest, corset, and chemise. The torrid zone begins with the belt and bands, and extends to the limbs below, for all the upper garments are continued below the belt, and all the lower garments come up as far as the belt, so that the clothing over the whole hip region must be at least double what it is over any other section. But it is more than double; it is quadruple, for the tops of all these lower garments have a superfluous fulness of material which is brought into the binding by gathers or by plaits." Indeed, the ordinary female dress, although it may be good in quantity and good in quality, is yet very prone to be bad by the manner in which the materials that compose it are distributed.

This unequal distribution of heat over the surface of the body is an offence against definite physiological laws, and cannot prove other than injurious. It may be that the injury inflicted is in many cases slight, but it is not on that account to be ignored. On the other hand, it must be asserted that under certain circumstances the ills that may arise from this faulty protection of the body may be very grave, and prove the source of special disease and "delicate health" to many women. The clustering of many garments about the waist is obnoxious in several ways. In the first place, the plan must cause some constriction of the waist and some pressure upon the abdomen; and, in the second place, it must maintain the part in an undesirable state of warmth when compared with the surface temperature of the rest of the body. A lady, writing upon this subject, asserts that it is possible for a woman clad in winter attire to have her waist encircled by *fourteen* layers of clothing material. This somewhat alarming announcement is explained by the statement that the garments attached about the waist are usually "attached to a double band" in each instance. Thus, the fourteen layers represent seven actual garments. The waist is the district between the lower ribs and the hip bones. It is a part readily constricted, and around it these nether garments are attached. There is no doubt that some portion of the weight of this clothing is borne by the hip-bone direct, and is, therefore, comparatively harmless, especially in women with prominent hips. But a certain amount of support for the garments must be derived from direct pressure of the waist, and this must be still more conspicuous in the stout and in those who, like the young, have slight hips. This constriction cannot fail to be injurious. It interferes with the proper action of the abdominal muscles and with the functions of those viscera that come within the line of pressure. It acts perhaps most injuriously upon the organs especial to women, and the change in the position of the womb that a tight band around the waist can produce has been demonstrated by a well-known writer on the diseases peculiar to the sex. I think that without doubt a number of these diseases, which are of alarming frequency and of no trivial character, may owe their origin to this heavy, ever-dragging coil around the waist, and in cases where some other cause can be ascribed to the malady, I imagine that this constant downward pressure and constricting force is an active agent in exaggerating the disease.

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* Mrs. Woolson. "Dress and Health." Montreal, 1880.

It must not be presumed that the pressure effects of many garments attached round the waist are obviated by wearing a corset beneath them. The pressure is merely modified and redistributed, while not one fraction of the weight is removed.

Then, again, this multitude of bands above and about the hips tends to keep the region unduly warm, and to lead to congestion of the pelvic viscera. These viscera, which include the organs especial to women, are from their position peculiarly liable to congestion, and it is not difficult to understand that many layers of warm clothing in the vicinity of these organs will increase that tendency.

While the hip region is somewhat too well provided with clothing, the lower extremities are imperfectly, and certainly injudiciously, covered. As an American physician oddly expresses it, "The legs, clad with one thickness of cotton, go paddling along under a balloon." This brings us to the consideration of the *petticoat* as an article of clothing, and especially as a covering for the lower limbs. This garment is, no doubt, of infinite value among primitive communities, where it forms the sole attire of the female population, but it does not appear to be suited to modern needs, nor is it the most sensible or economical way of clothing the lower extremities. One would imagine from the attire of the ordinary woman that she was a one-legged animal. To vaguely surround two distinct limbs with one garment is certainly the least direct method of clothing them, and to superimpose a second garment over the first when increased warmth is needed is a proceeding as lacking in reason as it is prodigal in material. Petticoats, however well they may suit the decorative aspects of dress, are, as articles of clothing, bad in many ways. Their weight is considerable; they seriously impede movement; by hampering the action of the lower limbs they involve an unnecessary expenditure of muscular force, and if long enough to reach the ground, they serve to accumulate dirt. These wretched garments limit immensely the out-door amusements of women—they put a tax upon all forms of exercise that involve a use of the lower limbs. They are an actual drag upon the wearer, and are one of the main obstacles in the way of the proper physical development of women. It is of little use to attempt to advise a woman to take a ten miles' walk on a winter's morning, in the place of sitting at home over a fire, if that walk involves the dragging about of a great weight of clothes that by dangling about the legs adds to the burden to be borne. Surely, the most reasonable way of clothing the lower extremities is by clothing each limb separately. Such a plan involves the need of only one garment (in addition to the outer dress or gown), no matter whether the weather be warm or cold, for when additional warmth is required it can be obtained by simply increasing the character or the thickness of the material used. If in winter women were to clothe their lower extremities separately with some suitable woollen fabric, they would be in no more need of petticoats than are men. Instead of the lower part of the body being hampered with a multitude of garments, there would be two only—an outer dress and a proper under-dress for the extremities. If a petticoat be needed for decorative purposes it could be added, but only then as an element in the ornamental province of dress. Such a costume would, I presume, present the same external appearances as are shown by the ordinary dress of the time; and in practically abandoning petticoats and clothing the lower limbs in a sensible fashion, women would be introducing no very terrible innovation. I think, moreover, that this method of clothing the lower extremities would be somewhat more decent than is the petticoat arrangement, and would render the position of a woman on a windy day less embarrassing.

The evils that have just been alluded to are exaggerated by long skirts, by "tied back dresses," and by heavily ornamented gowns. Every additional ounce of weight in the garments that surround the limbs means so much additional muscular exertion, and the dress, elaborately decorated by much superfluous material, represents a terrible and superfluous amount of work for muscles that are perhaps already burdened enough.

Tight Sleeves.—The evils attending upon the wearing of tight sleeves, although not considerable, are yet sufficiently pronounced to render such a form of clothing objectionable. Sleeves that tightly embrace the limbs interfere with the venous circulation of the part, and tend to make the fingers bluish and cold. In cases where the tightness extends well up into the arm-pit, some swelling of the hand and other inconveniences may follow. Pressure upon the nerves of the limb which, for the most part, run at no great depth beneath the skin, may lead to neuralgic pains in the extremity, or more probably to some numbness of the fingers. Moreover, the tight sleeve interferes seriously with muscular action, and restricts the range of movement of the arm. It is impossible for a person to grasp so firmly with the arm compressed by a sleeve as when the limb is free from constriction, and there is probably not a very great number of women who can *freely* make their hands touch over their heads. Dr. Vaughan—to whose essay reference has already been made—adds still another inconvenience to the tight sleeve. "I once knew," he says, "a woman come to be bled whose gown sleeve was so tight that the blood could not be stopped till she was persuaded to cut it."

Tight Lacing.—The subject of tight lacing has been for many years the *pièce de résistance* of all who have dealt with the hygienic aspects of dress. The popular lecturer, the popular writer, and the popular artist have all expended considerable pains and energy upon the subject. It has been attacked with the most violent abuse and condemned with the bitterest invective, and there are few ills to which flesh is heir that have not been ascribed by some one or another to this fashionable practice. In dealing with the matter, there would appear to be a tendency to reckless exaggeration and sweeping assertion, and a disposition to treat the subject with explosive and hysterical vigour. The practice of tight lacing is no doubt bad in more ways than one, but the disappearance of the fashion is not likely to be brought about by ill-considered abuse and imperfectly-substantiated statements. Few, for example, could treat with other than an incredulous smile the assertion of an American physician that tight lacing "has done more within the last century than war, pestilence, and famine towards the physical deterioration of civilised man." And coming more to facts one can only regard as remarkable the experience of a lady doctor who, at a post-mortem examination of some women with "the broad peasant waist," found that "in one case the liver had been completely cut in two, and was only held together by a calloused bit of tissue." This condition might have existed in the case referred to, but there would be few who would be bold enough to ascribe it to faults in dress in a female with "the broad peasant waist." I shall endeavour, therefore, in the following remarks to keep as closely as possible to actual facts, and to avoid conclusions that may be open to the charge of being strained and biassed.

Although the corset is comparatively speaking a modern production, yet the practice of constricting the waist would appear to be of some antiquity. Contemporary with the origin of the fashion there no doubt came solemn warnings as to its evils, and, according to Cerviotti, Hippocrates—who died B.C. 361—vigorously reproached the ladies of Cos for too tightly compressing their ribs, and thus interfering with their breathing powers. Those who are interested in the history of this extensively-abused article of dress will find a good account of its supposed origin and of its gradual development in Dr. Leroy's monograph, "Recherches sur les habillements des femmes. Paris, 1772."

In the first place, as a matter of common sense it must be owned that tight lacing cannot occupy a very high position. Considering the subject quite apart from any æsthetic grounds, and quite apart from any hygienic influences, the compression of the ribs and abdominal walls in a young and perfectly-developed woman must appear strangely unreasonable. I do not open up the question as to how far women whose figures are ill-formed or unsightly are justified in tight lacing to produce a more normal appearance, but take rather the simple fact of a female in robust health and of perfect outline who thinks fit for certain reasons to deform the body. In the strictest sense of the term, the body of a normal woman who is tight laced must be regarded as deformed. Through most ages and among most peoples some deformity of the body has been at one time or another fashionable. Professor Flower, in his admirable little book on "Fashion in Deformity," has dealt with many of these. Certain Indians, for example, think fit to flatten the head by means of pressure applied to the growing skull. The Chinese lady cramps her foot until it is neither fit to look at nor to walk upon. Among other nations it is fashionable to wear a bone thrust through the nose, or to deform the lower lip by inserting a disc of stone or metal beneath the skin. The civilised European of the present day prefers to compress her ribs, and to produce a certain modification in the outline of the body. As evidences of intelligence and of a reasoning faculty, these practices must all occupy about the same low level, and it is remarkable that in highly civilised nations—prone to recognise the absurdities of other less-favoured peoples—the production of bodily deformities should still be an essential item in fashion.

As a matter of beauty, the claims of the constricted waist have been somewhat severely criticised and opposed. Many of those who acknowledge that tight lacing may possibly be injurious to the health, and own that the practice in the abstract is not sensible, would yet contend for its maintenance, on the grounds that the narrow waist adds to the beauty of the outline and is the subject of much admiration. A desire to be attractive, and a love for admiration are potent influences on the female mind, and but a scanty knowledge of human nature would assure us that, with many, those influences will outweigh distant fears of impaired health. In discussing this matter, therefore, it is impossible to avoid some consideration of the æsthetic claims of the narrowed waist. In an anatomical sense, the most perfect outline of the female figure would be represented by that of a nude, young, normally developed

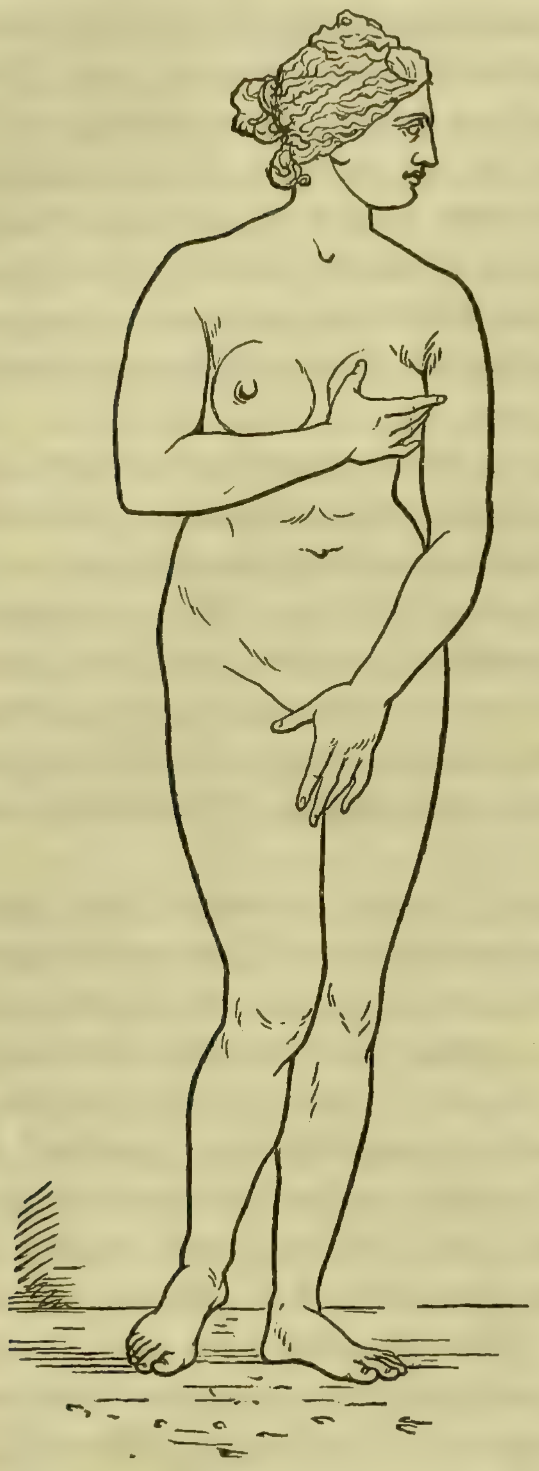

Fig. 1.—The Venus de Medici, showing the natural outline of the body.

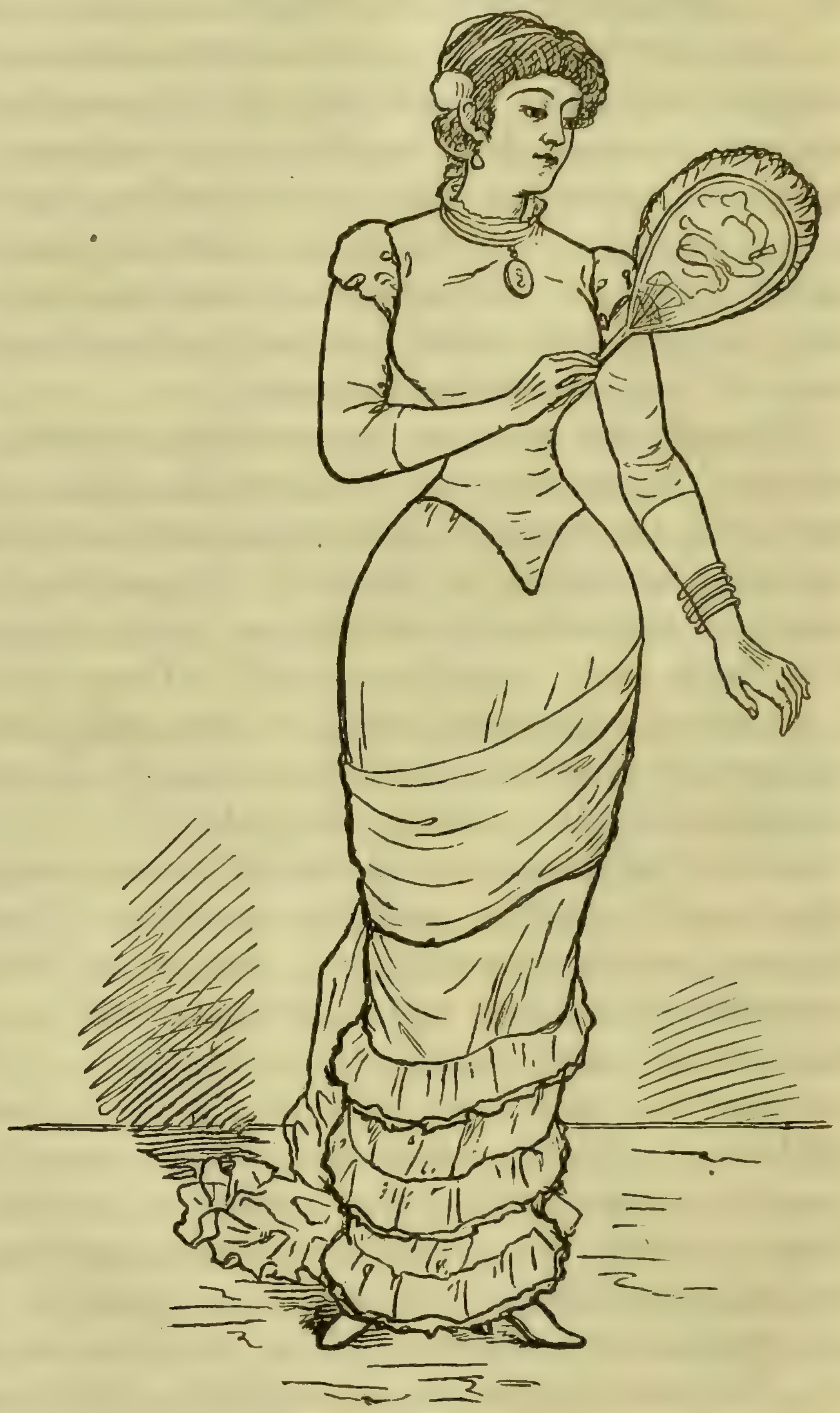

Fig. 2.—The outline of the body produced by tight lacing. (*From a photograph.*)

woman. Such a figure would, it is well known, present a waist some 26 or 27 inches in circumference; that would be regarded by many with absolute horror. Now, in all the most excellent attempts that art has made to give expression to female loveliness, this outline of the healthy and perfectly constructed woman has always been reverently preserved. It is the outline that has been made famous by the grandest statuary of ancient and modern times, and that has been the glory of the painter since the earliest days of art. Such an outline is well represented by the famous Venus di Medici (Fig. 1). Side by side with the drawing of this marble is a representation of a narrow waist—by no means extreme—which, to insure freedom from exaggeration, has been taken from a photograph (Fig. 2). There are some who would say that the Venus is coarse and unwieldy in outline, and maintain that the more modern figure gives a pleasant impression of trimness, and presents altogether a more agreeable configuration. Without discussing the matter at length, it can only be pointed out that the figure of Venus is the figure of anatomical perfection, of complete development, and of perfect health. If the outline be coarse and repulsive, then is nature coarse, and the expression of simple bodily vigour a thing to offend the eye. In the Venus there is a gentle sweep from the shoulder to the hip, all parts are in proportion, and the actual outline of the body precisely accords with the principles of beauty. In the modern figure there is an abrupt constriction of the waist; the shoulders and hips appear ponderous by comparison, the outline is pronounced and lacking in simple ease, and, so far as the anatomical eye can view it, the proportions of the body are lost.

One point remains to be noticed; there are some who, while they acknowledge the beauty of the outline of the nude figure, maintain that that outline is not adapted to the body when draped with clothing. They assert that the perfectly developed nude figure cannot be accepted as the standard upon which to judge the fittest outline of the clothed figure. They assert that the dress conceals the outline of the lower extremities, and substitutes an outline that is perfectly different, and that is not consistent with the configuration of the normal waist. It is insisted, moreover, that inasmuch as in the female the natural outline of the extremities cannot be decently represented in the clothed figure, the entire proportions of the body are altered, and so altered as to render a waist of natural dimensions no longer desirable. Thus is opened up the question as to how far any form of garment that reproduces the configuration of the nude figure is to be admired. Those who advocate the views just detailed maintain that some constriction of the waist is necessary to the female figure when dressed, in order to restore proportions that have been lost by the concealment of the lower limbs, and support their argument by mathematical data. I imagine that the decision of such a matter must be a question purely of individual taste and judgment, and to such a censorship the subject must be left at present. For my own part I hold the belief that that dress is the most becoming to women which the most accurately reproduces the exquisite outline of the nude figure, provided that such a costume offends in no way the strictest dictates of modesty.

One erroneous impression as to the anatomy of the female body may be conveniently noted in this place. It has been many times declared that the amount of "waist" varies in different women, and that some are naturally provided with a tapering waist. In answer to those who are impressed with this belief, it may be said that the amount of constriction that constitutes the waist does not vary in bodies of like size and of like development. Like all other anatomical proportions, the proportions of the waist are constant, other things being equal. If, however, the hips are unduly prominent, or unduly dwarfed, the waist may appear in the one case more distinct and the other less obvious. Obesity may obliterate the waist, and emaciation make it more pronounced. Young children and young girls have a less definite waist, owing to the fact that their hip-bones are relatively as well as actually smaller than are the same parts in the fully developed. No woman, however, enters this world with the "wasp-like waist" ready made, and under no circumstances can the fashionable constriction be developed without artificial means. This assertion is not affected by the fact that the narrowing of the trunk is, in some individuals, more easily produced than in others.

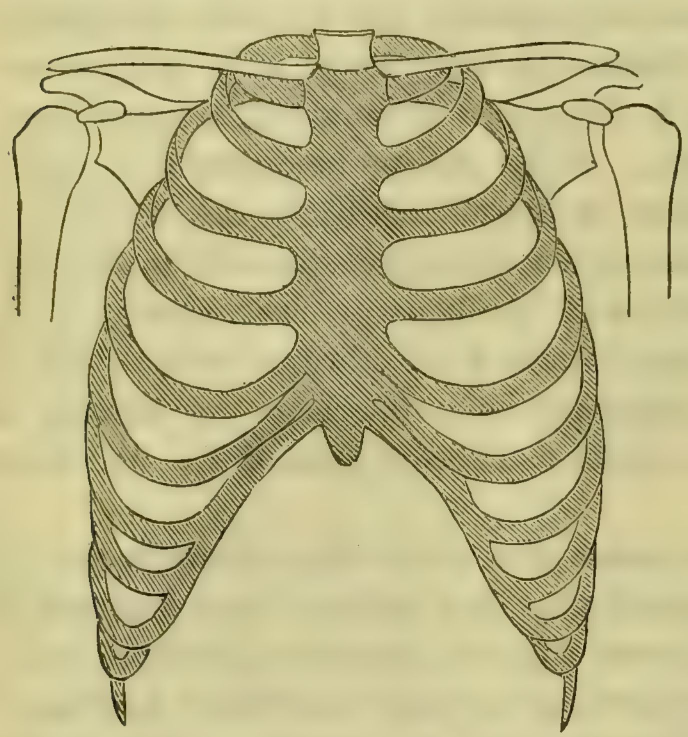

Fig. 3.—Natural Form of the Chest and Ribs.

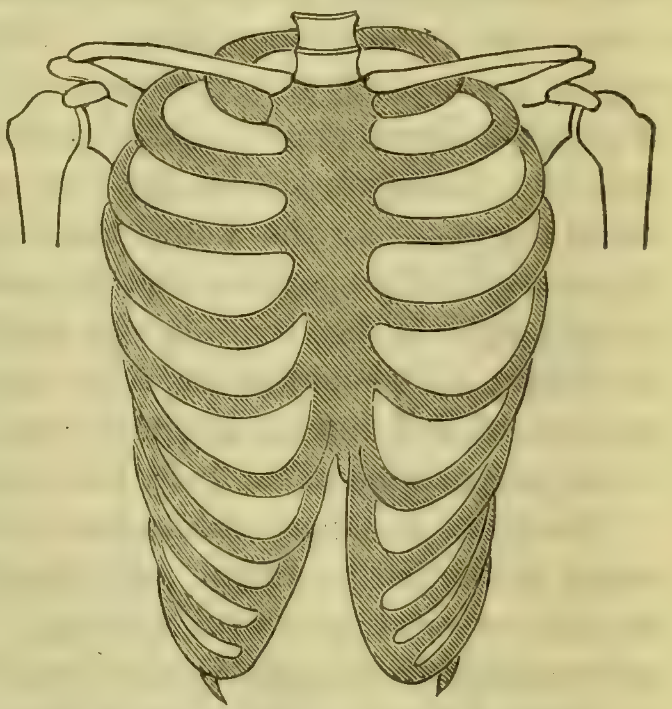

Fig. 4.—Deformed Chest, after tight lacing.

We are now in a position to consider in detail the effects of tight lacing upon *health*.

The natural waist, such as it is, consists of a narrowing of the trunk in the interval between the last of the ribs and the top of the hip-bone. A reference to the normal skeleton will show that this interval is by no means extensive, and that it affords the only opportunity for the development of a natural constriction of the soft parts. A study of the same diagram will demonstrate that no considerable or even moderate degree of constriction would be possible without a proportionate bending in of the lower ribs. The human skeleton is provided with twelve ribs on either side. The seven upper ribs are tolerably firmly fixed to the spine behind and to the breast-bone in front, so that their position cannot be greatly altered by compression. The five lower ribs are termed "false" ribs, and are only indirectly connected with the breast-bone in front; the last rib, and the last but one, being quite free from any attachments in front. It thus happens that these five lower ribs, having somewhat insecure union with the body, are so elastic that they can be more or less, pressed out of place without great expenditure of force. Indeed, I have been surprised, in experiments made upon the dead body, to find to what a considerable alteration in form these parts will submit if much pressure is brought to bear upon them. In tight lacing advantage is taken of these well-named "false" ribs, and it is upon them that the brunt of the constricting force is made to come. In the hour-glass figure produced by extreme tight lacing, the narrowest part of the artificial waist corresponds to the site of the natural waist. The tapering outline above this represents the result of the compression of the lower ribs. But below the site of the natural waist, the line of the body curves out again with considerable abruptness, the curve representing the hip-bones, that from their substantial build and firm connections are unaffected by the pressure. The alteration produced in the anatomy of a woman who laces tightly to any degree is very considerable, as may be seen by comparing the two skeletons depicted in Figs. 3 and 4.

When tight lacing is first commenced, the false position the parts are made to assume is only temporary; but when the practice has been long continued, the deformity becomes more or less permanent, and the constriction of the trunk is nearly as marked when the stays are off as when they are on.

The circumference of the waist in a perfectly developed and normal woman is from 25 to 27 or even 28 inches. This may be considered as the proper measurement of the part. The size of the artificial waist of course varies. During a time when narrow waists were particularly fashionable, a Frenchman observes that a perfect female waist should measure no more than 16 inches—a measurement that about corresponds to the circumference of the neck of an athletic man. The fashionable waist at the present time, is, I am told, from about 20 to 22 inches—a circumference that indicates no small amount of compression. It must be noted also that tight lacing not only alters the dimensions of the waist, but it also entirely changes its outline. The normal waist, as seen in horizontal section of the body (see Fig. 6), is more or less oval in outline, whereas the artificial waist is, or should be, perfectly round (Fig. 7).

The effects of this practice upon health may be considered under the following heads:—(1) The effects upon the viscera or internal organs. (2) Upon respiration. (3) Upon the circulation and the heart's action. (4) Upon the muscular apparatus of the trunk; and (5) upon the general outline of the body.

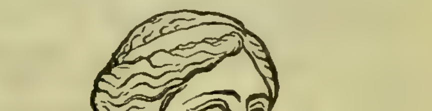

Fig. 5.—The Venus of Milo, showing the natural position of the viscera.

1. *The Viscera.*—The position of the chief organs concerned is shown approximately in Fig. 5, that displays the anatomy of the Venus of Milo. Arching across the body and separating the cavities of the chest and abdomen is the great muscular partition—the diaphragm. On the right side this extends nearly as high up as the nipple. Above the

diaphragm, and resting upon it, are the heart and the two lungs. Below it is seen the liver, a large gland that stretches nearly from one side of the abdomen to the other, and that should extend no lower than just beyond the line of the right ribs. Above the liver extends as high up as the diaphragm, with which it is in contact. Below the liver, on the left side, is the stomach, and beyond the stomach the spleen, covered by the ninth, tenth, and eleventh ribs, while between the lower ribs and the hip-bones are the two kidneys. The rest of the abdomen is occupied by the pancreas and intestines. Now all these viscera come more or less within the grip of the constricting force, although in the line of the narrowest part of the waist will only be found the intestines, and perhaps the kidneys. The abdominal viscera suffer, of course, the most, while the heart and lungs are only indirectly acted upon. There is a common impression that there is plenty of empty space somewhere inside the body, and if, by narrowing the waist, the organs *are* pressed out of their proper place, then they simply occupy some part of the spare room with which the human body is supposed to be so lavishly provided. I need scarcely say that there is not one fraction of an inch of superfluous space in the body of man. The organs fit the one against the other so closely that if one become enlarged or displaced the effect of the change is observed upon its surroundings. In Fig. 6 the intimate mutual relations of the chief viscera are shown, and the closeness with which they fit the one against the other. If the natural waist be constricted to a size represented relatively by Fig. 7, it will at once be obvious that something must happen to the viscera. They must either be pushed up or pushed down, as there is no room for them in the line of the constrictive force. Fig. 8 shows diagrammatically a horizontal section through the lower part of the chest. It will be seen from the drawings that any movement upwards of the liver or any increase in its dimensions must affect the organs that are here adjacent to it —viz., the heart and lungs. Let all those, therefore, who practise tight lacing (if even to a slight extent) distinctly understand that the narrowing of the waist is effected mainly at the expense of the internal organs. The smaller the waist you wish to obtain, the more must you compress those organs. It is no question merely of squeezing-in skin, and muscle, and bone—it is a question of squeezing-in lungs,

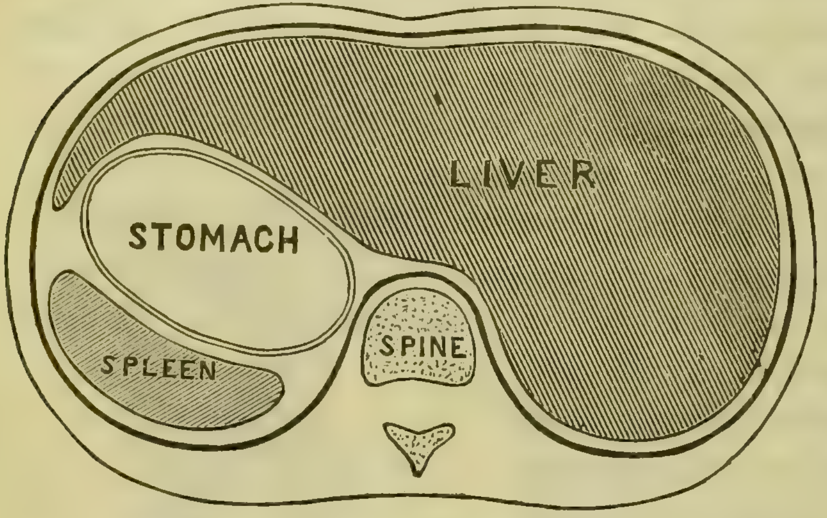

Fig. 6.—Section of the Body with a natural waist, showing the space available for the viscera and their natural position.

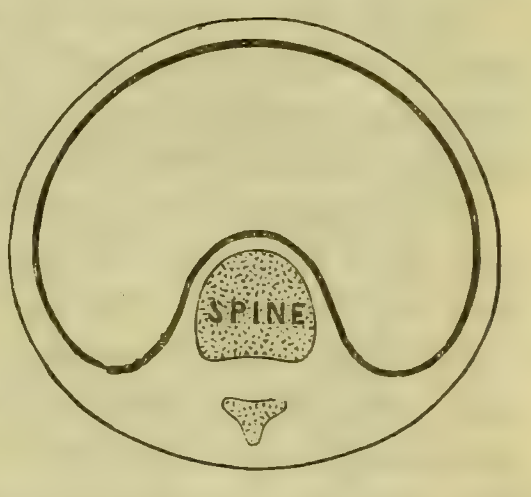

Fig. 7.—Section of a Body with a deformed waist, showing the altered outline and the greatly diminished space available for the viscera.

and stomach, and liver. An examination of the body after death of those who have practised severe tight lacing shows forcibly the effects of the practice. The liver is found pushed down, and more or less dislodged from its proper place. Moreover, it will appear indented by the ribs, and these indentations mean that the ribs have been so forcibly driven into the liver as to leave permanent indications of that fact. In like manner the stomach will be dragged out of position and is often structurally altered. The diaphragm is pushed up, the lung space is encroached upon, and the heart often suffers no inconsiderable displacement.*

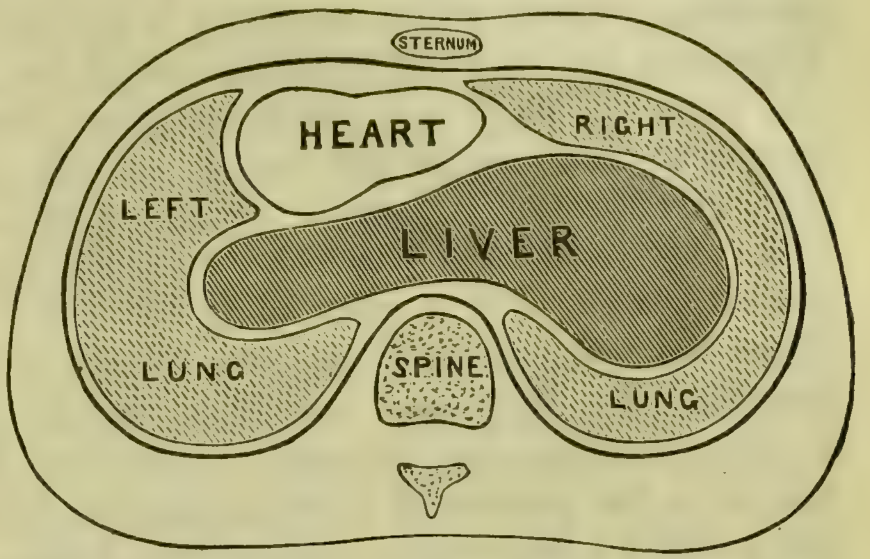

Fig. 8.—Section of the body through the lower part of the chest, showing the viscera displaced by tight lacing.

How does all this affect the health? The liver is an organ whose importance in the general economy cannot be well exaggerated. Through it passes the blood concerned in digestion, and in addition to this the organ itself takes an important and essential part in the act of digestion. The result of the pressure from tight lacing is that the circulation through the liver may become impeded, and the function of the gland disturbed. As a result of this (aided by changes elsewhere) various forms of dyspepsia become common, and following upon them may come some part of that general mal-nutrition often noted in the miniature-waisted. It has been pointed out that the malady known as gall-stones is more common in women than in men, and it has been suggested, with some reason, that this disproportion is due to the peculiarities of female dress.† Pressure upon the stomach may cause gastralgia, indigestion, nausea, vomiting, and other inconveniences. A serious and sometimes fatal disease—ulcer of the stomach—has been shown to be capable of being produced by the practice of tight lacing, and to the same practice may often be assigned many forms of colic, and that ailment known to the laity as "spasms." Upon the organs peculiar to the female the pressure effects of tight-lacing have a particularly baneful effect, and there is no question but that the practice has led to serious and incurable affections of those parts. A recent author, dealing with these diseases, recognises improprieties of dress as a frequent and vigorous cause of these special ailments, and points out the manner in which displacements of the womb can be produced by constricted waists.‡

2. *Respiration.*—The diaphragm is a muscle concerned solely in the act of breathing, and its function therefore is of the highest importance. It unfortunately happens that the attachment, or base of action of this muscle, is represented by the very ribs that help to form the hour-glass waist. The result is, that in a tightly-

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* For cases examined after death, see, as examples, *Lancet*, vol. i., 1871, p. 256. *Ibid.*, vol. i., 1868, p. 675. *Ibid*, vol. i., 1861, p. 5 (two cases).

† *Med. Soc. Trans.* vol. v., 1881, p. 18.

‡ Dr. Thomas: "Practical Treatise on the Diseases of Women," 1881, p. 45.

laced individual the diaphragm can have but little action, and the breathing power becomes thus seriously restricted. A simple experiment with the spirometer will show that a woman, even if she adopts but a slight constriction of the waist, has much greater breathing-capacity with her stays off than with them on. The breathing in tight lacing, however, is not only impaired by interference with the diaphragm, but by the constriction also of the ribs. In the act of respiration the ribs move freely up and down, but when the body is gripped by a corset the movement of the lower ribs can be scarcely possible. In addition to these evils, the lungs themselves must be subjected to a more or less serious compression. It is easy to surmise how this tampering with important organs will affect the general health. Air is essential to life, and it must be breathed freely and fully. There are few who have not some idea of the effects of an insufficient supply of pure air. The tight-laced individual may be surrounded by plenty of oxygen, but so compressed are her breathing organs that she cannot draw it into her lungs. She is in the position of a person starving in the midst of plenty. Any one who has watched a wasp-waisted lady after a dance, must have noticed the unsightly and exaggerated heaving of the upper part of the chest, which is merely an expression of Nature's efforts to obtain a proper supply of air.

Apart from these immediate effects there are certain remote effects. Among these may be mentioned the languor, the unfitness for vigorous exertion, the sensation of lassitude of which so many tightly-laced ladies complain—symptoms due to no small extent to the persistent and gross interference with the natural act of breathing, aided by the mal-nutrition incident upon impaired digestive functions.

3. *Circulation.*—As already stated, undue constriction of the waist may cause some displacement of the heart, but it also serves to seriously embarrass the general circulation. This is effected mainly by an interference with the blood-current in the lungs and great abdominal viscera, whereby an unnecessary strain is thrown upon the heart. The victims of miniature waists are often troubled with palpitation, and are liable to faint, or at least feel uncomfortable, after unusual exertion. Two or three cases have been recorded in the medical journals of death from apoplexy in young women who were extravagantly tight laced. A visible disturbance of the blood circulation of the face has long been popularly associated with the tapering waist, and it is a common taunt to assert of a much constricted woman that her corset is too tight to allow her to sit down without her nose becoming red.

4. *The muscular system of the trunk.*—The injurious effect of tight corsets upon the muscles of the back is very obvious. The spinal column is kept erect by a large number of important muscles that run down the whole length of the trunk. It is well known that the more a muscle is exercised within reason, the larger and more vigorous does it become; the disused muscle, on the other hand, becoming wasted, flabby, and greatly impaired in strength. When close-fitting and rigid corsets are used, the responsibility of supporting the back falls to a great extent upon the corset; the function of the muscles is more or less superseded, and from long-continued disuse they become wasted, shrunken, and enfeebled. They undergo, indeed, the same changes that the muscles of a man's arm would undergo should he

think fit to keep the limb fastened to a board for any length of time. The back of a woman who has long worn stays is emphatically ugly. It will be found to have lost its agreeable outline; the shrinking of the muscles will have caused the bones to appear unduly prominent, and the general aspect of the part will be flat, inert, and expressive of defective development. During the period of growth the muscles require frequent and vigorous exercise; and if young girls, and even young women, persistently wear stays, it follows that their muscles suffer unusually; the function of those muscles is absorbed by the corset, and the longer these so-called "supports" are worn, the more indispensable do they become, and the more completely are they relied upon for the support of this most important part of the body.

Muscular weakness in the structures that maintain the erect position of the spine may lead to curvature and other deformities of the back, and thus it is that the use of rigid corsets in young people has been so generally condemned by surgeons as a most efficient means for producing spinal ailments.

In the same way the use of corsets tends to weaken the abdominal muscles, because they, to a certain extent, absorb the function of those muscles, and allow them to waste from disuse. Thus some undue protuberance of the abdomen is not uncommon in those who have long worn stays, and this additional deformity has necessitated an additional evil, in the form of certain abdominal belts.

5. *The general outline of the body.*—Not only does tight-lacing affect the outline of the figure at the waist, but it must produce changes also in the configuration of other parts of the body. It tends, in the first instance, to make the shoulders high and square. This is due to an expansion of the upper part of the chest that is compensatory to the compression of the lower part. At first the high and square shoulders of tightly-laced women may not be considered to be unsightly. The body is certainly made to assume a somewhat triangular outline, and the graceful slope of the shoulders is lost. But this change in figure is tolerated as seeming to exaggerate the smallness of the waist, for the wider the shoulders and the broader the hips the more microscopic does the waist appear. As years advance this deformity of the upper part of the body usually becomes more pronounced, and is unmitigatedly ugly. The high shoulders become round, cumbrous, and unsightly, while the increased breathing efforts of years will have caused an undue prominence of the upper part of the chest, that adds to the general shapelessness. Tight lacing, moreover, can never allow of a graceful and easy carriage. The introduction of a rigid stiffness about the middle of the body will quite prevent that, and will render most of the movements constrained and angular. If the power of tight lacing for causing wasting of muscle be borne in mind, it will be understood that of all means that the ingenuity of man could devise for preserving the youthfulness of the figure, there is perhaps none that will prove more useless, or that will more completely defeat its own purpose, than the persistent wearing of an arrangement of steel and whalebone.

In concluding this part of the matter we might approach the question so often asked: *"Are stays a necessity?"* Many women assert that they derive great comfort from stays, that they support the body admirably, and that without them the wearer feels inclined to "drop to pieces." All this may be perfectly true. But what significance must we attach to the statement that certain women cannot possibly do without stays? Do they mean for one moment to assert that the human body is so ill-constructed and so badly adapted for its purpose in life that it has to depend for its integrity upon the productions of a corset maker? Such an assumption is simply outrageous, the true explanation being that by the persistent use of stays the muscles of the back have become so enfeebled (from prolonged disuse) that they are no longer able to support the spine. Those who declare, therefore, that they cannot do without stays, adopt the argument of the opium-eater who maintains that he cannot do without his opium. The long-continued use of the drug has so impaired his system that he feels a constant craving for it. And those who cannot exist unless braced up by corsets have so enfeebled a part of their system that they cannot do without the support upon which they have so long depended.

Such, then, are the principal evils—and they are neither few nor insignificant—that exist in the ordinary female attire of the present time. It now remains to endeavour to indicate the means whereby these evils can be done away with, and to point out in a general manner the requirements of a healthy form of female dress.

A Hygienic Costume.—In the first place woollen materials of some kind or another should be worn next to the skin, and should replace the linen garments that are so commonly worn and that are for so many reasons objectionable.

The garment that comes in immediate contact with the skin should be shaped to the outline of the body, so that it may fit comfortably and without compression, and in order that superfluous weight and needless folds and creases about the waist may be done away with. The garment, moreover, should be provided with sleeves, so as to clothe entirely the upper extremities, and should reach as high as the root of the neck. A continuation downwards of the same article of apparel may clothe in a like complete manner the lower extremities, and by such arrangement avoid the suspension of needless garments about the waist. Additional warmth for the lower limbs should be provided by additional clothing applied to each extremity separately, and the wearing of petticoats should be avoided so far as is consistent with the requirements of decency and a reasonable demand for ornamentation and display. The Viscountess Harberton has designed a dress, known as the "divided skirt," that is intended to meet some of the principal objections raised against the ordinary female costume of the time. By means of this dress each limb is separately clothed by its own "skirt," and the extremities are thus clad by what are practically trousers. By an ingenious arrangement of the material, however, the division between the two limbs is scarcely obvious, and the general aspect of the costume is much less pronounced than may be imagined. This form of garment is certainly sensible, and fully in accord with hygienic principles, and it only remains to be seen how far it will fulfil the sentimental and æsthetic requirements of modern dress (Fig. 9).

Under no circumstances should any portion of the dress be allowed to constrict the body or press unduly upon any part. If garments have to be applied from the waist, they should be suspended rather from the shoulder by braces, in the same manner as are the nether garments of men. Or if, by reason of sloping shoulders or from other causes, braces are objectionable, the garments that require suspension may be attached by buttons to a "bodice" made of some fairly stiff material, and continued over the shoulders. All bands about the waist are highly objectionable, and are, moreover, quite needless. Specially should care be taken that the articles of dress are so arranged as to cover the body evenly and maintain it everywhere at a proper temperature. The weight of the garments worn should be reduced to a minimum, and all such absurd appendages as "bustles," "panniers," and "crinolettes" are to be rigorously condemned, not only on account of their weight and the needless local warmth that they encourage, but because they appear somewhat inconsistent with the intelligence of a people who are by so many generations removed from the extravagantly attired savage.

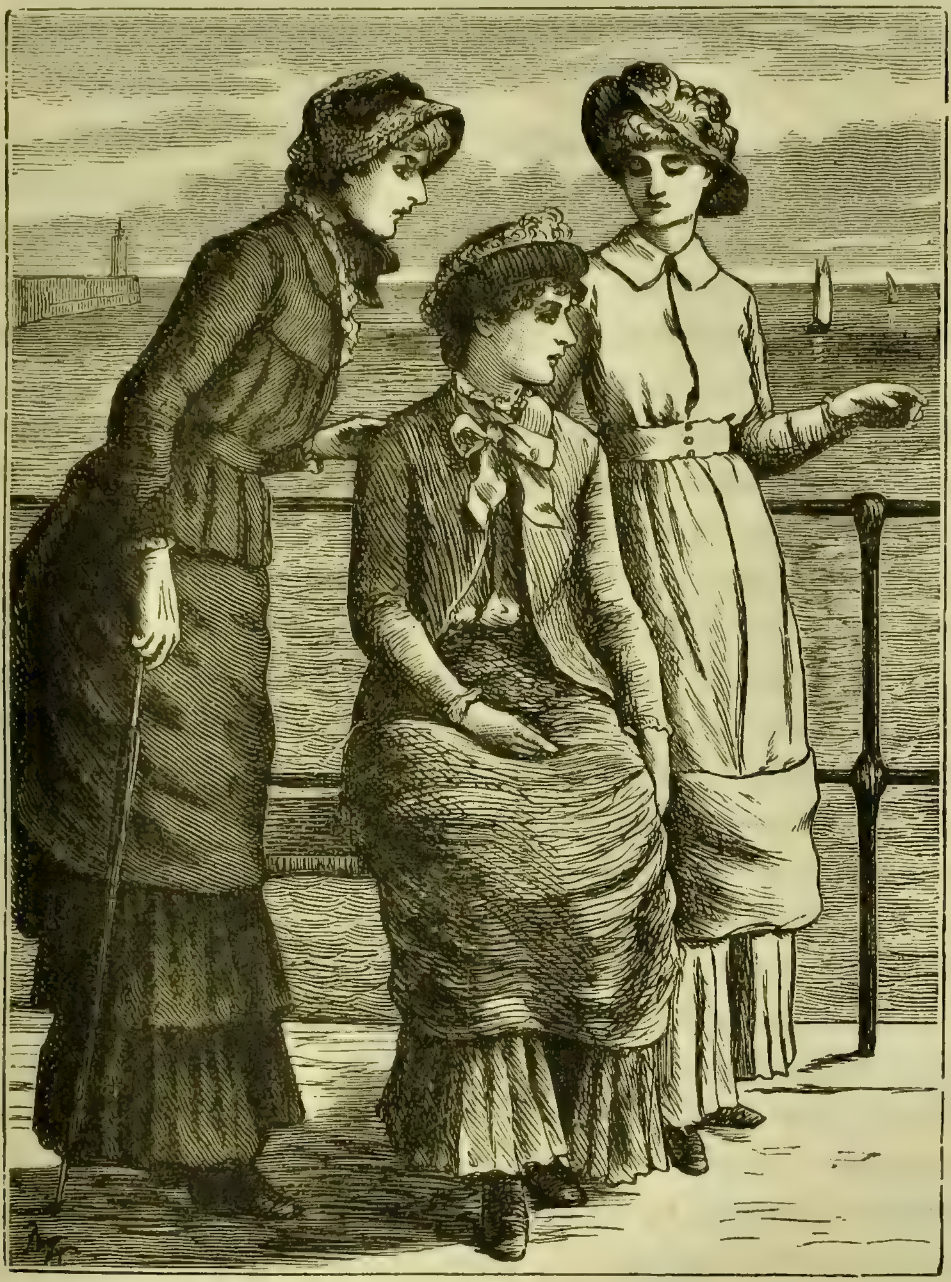

Fig. 9.—The Divided Skirt.

With regard to stays, I would say that corsets composed of rigid bars of steel and of many whalebones are necessary to no woman who is neither diseased nor deformed. I would not go so far as to say that stays of all kinds should be entirely given up, but would allow that in certain individuals a modified corset, slightly stiffened, and incapable of exercising constriction, is necessary for the sake of both comfort and appearance. Under no circumstance does a young girl require stays of any kind, and in the majority of young women they are equally needless and almost equally injurious. One sometimes hears the remark that a young girl who is growing rapidly requires some support for her back, and it naturally follows that that support is supplied in the form of stays. No delusion can be more complete than this. The weakness that is usually experienced in the back of a young girl is muscular weakness. The muscles in ninety cases out of a hundred have not been properly exercised, and the child, instead of being allowed to romp, has been kept propped up on a music stool, for hours daily, "practising." If the muscles that support the spine require strengthening, let them be strengthened in the only way that nature provides, viz.—by exercise. Let the child modify her pursuits, and indulge in some more reasonable form of muscular movement than is at present considered proper for most young girls. To wear stays is actually to increase the evil, and would only be equalled in folly by the action of a man who, finding the muscles of his arm weak from disuse, would proceed to bandage them up and exercise the limb still less. With regard to fully developed women, I think that no species of corset is necessary for those who are thin and slight in figure. For the purposes of appearance and for the more ready adjustment of dress they may wear a bodice composed of some stout material, but a cage of whalebones and steels is as needless as it is injurious. On the other hand, for women who incline to stoutness or who present an undue prominence of the bust, as well as for those who are mothers, a modified and simple form of corset is necessary for comfort, if for no other reason. The corset should be made of some stiffened material, should be slight in make, free from all rigid materials, and devoid of any constricting bands. It will fulfil all the points that the more temperate in dress consider necessary, and at the same time will have in no way an injurious effect upon the health.

The Hands.—The hands, like the face, require very little covering, while, on the contrary, their usefulness is apt to be somewhat interfered with by gloves. The blood supply of the hand is liberal, and the circulation within it free, and it is thus well able to resist ordinary cold, and to be indifferent to ordinary fluctuations of temperature. Except in quite cold weather, gloves may be regarded rather as ornamental than as necessary to a perfect attire. The constant wearing of tight kid gloves must somewhat impair the circulation of the part, and render the hand attenuated by discouraging the proper use of its muscles. A white and emaciated, or "delicate" hand, is, however, at the present time admired in ladies, and there is, therefore, some reason for constant glove wearing. Individuals with feeble circulations, as well as those who are liable to chilblains on the hand and to chapping on exposure, are obviously more in need of some hand-covering than are persons in perfect health. According to Dr. Buck, silken and woollen gloves are more apt to lead to chapping than are gloves made of kid or dog-skin. The kid glove, by the density of its structure, affords protection against wind, but as a protection against cold it is comparatively valueless.

The muff must be included in the consideration of hand-clothing. This strange appendage is probably regarded as purely ornamental, for as a means for keeping warm the hands it is ridiculously extravagant. It has, I presume, the doubtful advantage of allowing ladies to wear thin gloves with impunity during cold weather. But against this advantage must be placed the weight of the appendage, the muscular effort required to support it, and the impediment that it offers to an easy gait by demanding that the wearer should walk with her hands pinioned in front of her.

The Feet.—The blood circulation in the foot is neither so copious nor so free as it is in the hand. This depends partly upon the more dependent position of the extremity, and partly upon its greater distance from the heart as the centre of the blood supply. It is desirable, therefore, that the foot should be well protected, and so covered as to best prevent any loss of the normal animal heat. A multitude of evils have been ascribed to cold feet, many rightly, and many, perhaps, without sufficient reason. A greatly diminished amount of blood in the lower extremities means an unnecessarily large amount elsewhere, and consequently an unequal circulation. It is not difficult to understand that this irregularity in the blood supply may cause various evils, and, whether injurious or not injurious, it must at least be owned that cold feet are not comfortable.

Stockings and *socks* should be made of some woollen material that may vary in thickness and density according to the time of the year and the general requirements of climate. Woollen fabrics are selected on account of their feeble conducting properties, and for the other reasons that have been already mentioned. Cotton stockings are in every way to be condemned. In cold weather they do not afford sufficient warmth to the extremities, and in warm weather they are apt to encourage those abrupt fluctuations of temperature that—as already pointed out—are so undesirable. Those whose skin is unduly susceptible to woollen substances may wear silken stockings in hot weather, and in cold weather the necessary woollen foot-covering may be separated from the skin by a thin stocking made of silk. It is most desirable that the sock, or stocking, should not fit so tightly as to compress the foot or alter the position of the toes, and particular objection must be taken to such stockings as are pointed at the extremity. A proper foot-covering should accurately fit the foot, and be of the same shape as the sole when pressed upon the ground. Stockings that are too short are bad in that they cramp the toes, while those that are too long involve a mass of superfluous material at the extremity of the boot. Children are, perhaps, the greatest sufferers in this latter respect, being often provided with shapeless socks that, with the economical object of "allowance for growth," contain an amount of superfluous material. In 1792, Dr. Vaughan of Rochester* strongly urged that "stockings should be made with toes, as gloves are with fingers." Such digitated stockings are to be advised, inasmuch as they more completely clothe the feet than do ordinary stockings, they are probably more cleanly, they prevent an unnecessary mass of material at the extremity of the boot, and they do not permit of the formation of soft corns between the toes. Stockings should be supported by means of "suspenders," either attached to a shoulder brace, if such be worn, or to the bodice, by means of buttons. Garters are in every way to be condemned. They compress the superficial veins of the limb, and, by driving the blood into the deeper parts, are instrumental in causing the pain and sense of weariness that is often complained of in the limbs. Moreover, this compression of the veins is more or less certain to lead in time to the development of varicose veins.

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* "An Essay, Philosophical and Medical, concerning Modern Clothing," page 110.

Boots and Shoes.—Before considering the question of boots and shoes, it will be well to draw attention to some general points in the structure and configuration of the foot.

The human foot is composed of twenty-six bones of various shapes and sizes, held together by a number of strong ligaments. These bones are so arranged that, while by the size and compactness of some of them great stability is given to the foot, by the number and articulation of the others the member derives its elasticity and its power of modifying the effects of shocks transmitted to the body. The foot presents two main arches—one extending in the long axis of the foot from the base of the toes to the heel, the other passing transversely across the sole about its centre. These arches being of greater degree in one part than in another, it happens that the inner side of the foot presents a much greater amount of curvature than does the outer side. To the arch thus rendered so obvious on the inside of the foot the name of the instep is commonly given. A section of the foot (Fig. 10) shows that while the hinder part of the long arch of the foot is composed of two large bones only (os calcis and astragalus) the front part or pier of the arch is made up of many small bones, presenting a variety of outlines. By this arrangement it comes to pass that the posterior part of the arch gives stability to the foot, and supports (through the heel) the main weight of the body, while the anterior segments give spring and elasticity to the member. The comparative value of these two parts of the arch can be estimated by jumping from a height and alighting first on the heel (or rigid part of the arch) and then on the bases of the toes (or the elastic portion of the arch). The integrity of the pedal arches is maintained by ligamentous and muscular structures, and is essential to the proper function of the foot and to a perfect mode of progression. When from various causes the natural foot arches are lost, the individual is said to be suffering from "flat foot" or "splay foot."

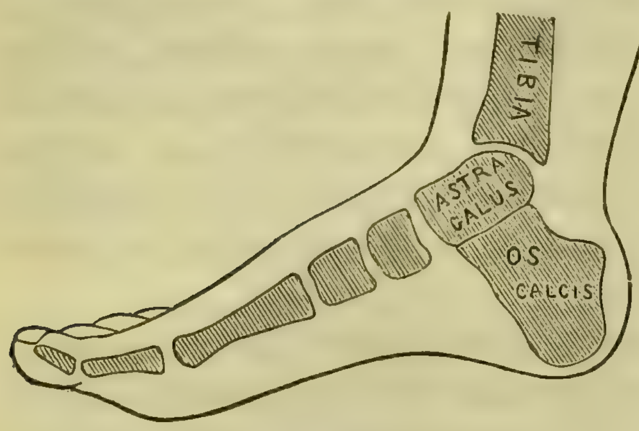

Fig. 10.—Section of the Foot.

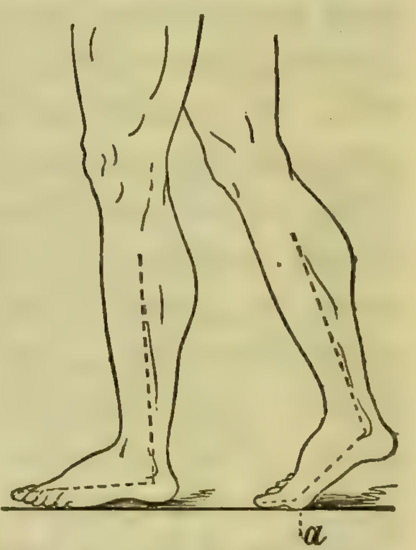

Fig. 11.—Action of the Foot in Walking.

The mechanism of the act of walking is somewhat complicated, but so far as our present purpose is concerned it is merely necessary to note one important fact. Most essential to proper progression is the series of transverse joints that run across the breadth of the foot at the part known as the "tread of the foot" or "the balls of the toes." This spot is indicated in Fig. 11 by the letter "*a*." In the act of walking a free bending of the foot at this part is indispensable, to allow of the performance of certain necessary lever movements. If the line of the foot, when it rests on the ground, is represented by a straight line (as in the front foot in Fig. 11), then when the heel is lifted from the ground in the act of walking, that line will no longer be straight, but will become angular opposite the bend of the foot (as in the hinder limb in Fig. 11). It will be seen at once that a boot with a rigid sole will quite prevent this action; but of this more will be said presently.

In taking note of the outline of the sole of the foot it will be seen (Fig. 12A) that the front part of the sole is broader than is the heel part, and also that the great toe is parallel to the axis of the whole foot. Now, in the shaping of a boot it will, I presume, be allowed that the boot ought to be made to fit the foot, and not the foot a boot having an arbitrary outline decided by the fashion of the time. It happens that the ordinary shoe has little or no relation to the natural outline of the sole (Fig. 13). The fashionable boot terminates in front in a more or less pronounced point, and the part occupied by the toes is usually its very narrowest part. The ordinary shoe is made on the principle of bilateral symmetry, and apparently on the assumption that each foot is divided into two perfectly symmetrical parts. As one writer on the subject well observes, the fashionable shoe is made of a certain shape "as if the human foot had a great toe in the middle and a little toe at each side, like the foot of a goose."*

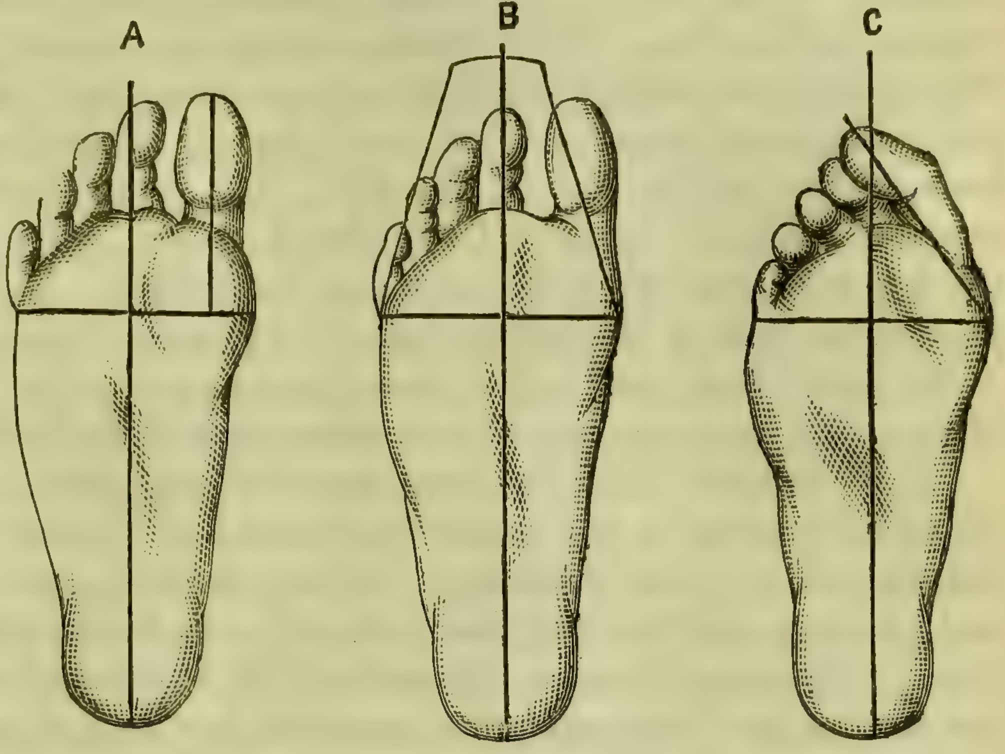

Fig. 12.—A. Natural Foot. B. Foot with outline of boot. C. Foot distorted by boot. (*From Prof. Flower's "Fashion in Deformity."*)

Why this particular shape should be admired it is difficult to say. There is nothing unsightly in the perfect human foot, and it is hard to understand why a boot that more or less completely reproduces the normal outline of the member should be considered as repulsive. The active spreading toes of a child's foot are certainly more to be admired than are the crushed and distorted toes of the shoe wearer; and the perfectly shaped feet made familiar by good statuary have surely an outline that is in itself more agreeable than is the rigid and wedge-like outline of the fashionable shoe. Fig. 13 shows the kind of impression that would be left upon the ground by a normal foot, and the utter lack of resemblance between that impression and the outline of the ordinary boot sole is somewhat unpleasantly conspicuous.

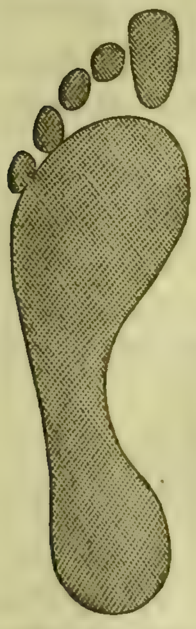

Fig. 13.—Impression of Normal Foot.

If well developed feet are placed side by side and heel to heel, the two great toes will be found to be parallel to one another, and to touch one another almost to their very ends. If the same feet, clad in the shoes of the period, are placed in the same position, it will be found that, while the heels are in contact, the inner borders of the two soles diverge, and that the tops of the two great toes will be separated by a considerable interval. Now, for the proper performance of the functions of the foot it is essential that all its movements should be unrestricted, that the toes should have free play, and that the great toe—which is so indispensable to the act of progression—should have a free range of motion, and maintain its parallelism to the long axis of the foot. What effects, however, do ordinary shoes have upon the feet? The toes become crushed together, and are often made to overlap one another; the great toe is no longer in a line with the axis of the foot, but is pushed outwards towards the middle line of the sole. The joints between the many bones are rendered rigid; the muscles, being unable to act, waste; the ligaments shrink, and the foot becomes a deformed, rigid, and inert block. In addition to these ill effects the delicate arch of the foot becomes broken down, the natural spring and flexibility of the part is lost, and by this loss of movement in the foot a greater expenditure of muscular power is demanded in other parts of the body.

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* "The Foot and its Coverings," by James Dowie. London, 1861.

The distorted member becomes decorated with corns and bunions, and occasionally presents the condition known as "in-growing nail." Robbed of its natural outline, of its elasticity, of its very strength, and shrunken by long inactivity and pressure, the foot that has long worn the fashionable shoe is in truth a sorry object. So general is some deformity of the foot from boot-wearing, that among the great majority of the population a normal foot is a thing difficult to be met with. So long ago as 1857, Bonomi laments that "from the antique alone can any knowledge of what is beautiful in the adult human foot be derived,"* and it is indeed possible, if the passion for badly shaped boots should be of long duration, that the proper configuration of the adult foot may become a mere matter of history.

A boot, to be properly shaped, should conform to the normal outline of the sole, and should exactly reproduce the natural proportion of the foot. The foot should not be measured—as is usual—while it hangs inert and removed from the ground, but the estimate of the proper shape of the member should be formed when it rests upon the ground, with its parts spread out.†

From what has been already said about the act of walking, it will follow that some flexibility in the sole of the boot is indispensable. This is provided for by what is known as the "waist" of the shoe, but this waist is placed—so far as my own impression on the matter goes—too far back, and too much removed from the tread of the foot where the natural movement actually occurs.

A perfectly rigid sole to a boot destroys the main action of the foot in the act of walking, and entirely prevents that bending of the front part of the foot that has been already alluded to (Fig. 11). The evil effects of an entirely rigid sole are well illustrated by the boot commonly worn by the agricultural classes. In this boot, not only is the sole of enormous thickness, but it is rendered still more rigid by the addition of a multitude of formidable "hob nails." It is stated that the ordinary army pattern Blucher requires a weight of 28 lbs. to bend the waist of its sole, so that the wearer of such a boot, to use the foot properly in walking, would have to expend an amount of superfluous muscular energy equivalent to 28 lbs. weight at each step taken.*

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* "The Proportions of the Human Figure." London, 1857, p. 19.

† In connection with the present subject, see "The Human Foot and the Human Hand," by A. Humphry (London, 1861); also "Why the Shoe Pinches," by Hermann Meyer (Edinburgh, 1860).

The absolutely rigid sole of the bucolic boot serves to account to a great extent for the ungraceful gait of the ordinary yokel. The natural play of the foot and toes being lost, and the motion of the ankle much impaired, he has little use for his leg muscles, and these becoming atrophied, produce the shapeless and comparatively small calf that he will usually present. The yokel walks mainly by a swinging movement from the hip, and so far as his feet are concerned he would walk more elegantly if he were to have them amputated and a rounded stump affixed in their place. The common wooden sabot is even less obnoxious than is the absolutely rigid boot of the English peasant. The sabot has a curve to its sole that allows of a rolling movement of the foot, not unlike the natural bending of the foot. Moreover, it is generally loose enough to allow of considerable play of the foot and ankle joint in the act of walking. The sabot is also, I imagine, of less actual weight than is the foot-covering of the so-called clodhopper. The sole of any boot, therefore, that is not as flexible as it should be will tend to encourage in a minor degree some of the evils that are so conspicuous in the wearer of a shoe with a perfectly unyielding foundation.

Boots should be made of leather that is as soft and pliable as is consistent with strength. Some of the thin frail boots that are worn by ladies are mere apologies for a foot-covering. They can neither afford a common protection to the foot, nor shield it from the cold, nor preserve it from wet and damp. Cotton stockings, and tight boots made of the thinnest possible material, are among the main causes of the cold feet so commonly met with in women. Elastic sides to boots may prove a source of evil by unduly compressing the foot and thereby interfering with its circulation. It so happens that two of the principal veins that return the blood from the feet run just beneath the skin, and are, therefore, very readily affected by pressure. The blood being forced from the superficial veins tends to produce an engorgement of the more deeply-seated vessels, with certain possible inconveniences. A case has been recorded—in the person of a medical man—where severe pain in the soles of the feet was induced by wearing elastic-side boots. The pain ceased with the removal of the elastic portion of the boots.†

Certain obvious advantages attend the wearing of boots the upper parts of which are made of cloth or some like material. Such boots, however, could only be worn under certain conditions. Boots or shoes that are too short not only cramp the toes and tend to bend them up, but they are also apt to produce a curving of the nails that may lead to the troublesome ailment known as in-growing toe-nail. While it is allowed that boots that are too tight are bad, it must also be borne in mind that boots that are too large may prove to be objectionable. Such boots allow the feet to shift about within them, undue friction is thus encouraged, and feet encased in too ample shoes are apt to become abraded and to develop corns. Moreover, the loose connections between the foot and its covering render walking less easy, by creating a demand for some additional muscular exertion.

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* *Lancet*, vol. i., 1865, p. 488.

† *Lancet*, vol. ii., 1866, p. 718.

High Heels.—Into the matter of the comparative beauty of high heels and no heels I do not propose to enter. Shoes require heels of some kind, but they should not be out of proportion to the rest of the foot. The heel of a boot for a fully-grown man should not exceed three-quarters of an inch in height, should be placed well back, and should be as large as the natural heel. The height of boot-heels for other individuals can be estimated from this. Unduly high heels to shoes are objectionable in many ways, especially when they are disproportionately small. In the first place, they diminish the stability of the foot by placing beneath the natural heel one more segment in the support upon which the weight of the body, as transmitted through the leg, must rest. (Fig. 14). They produce a false position of the body by tilting up the heel, and by thereby placing the foot in the position it assumes when the individual walks on tiptoe. (Fig. 15.) The mechanism of the foot is impaired, and undue muscular exertion is demanded in the act of walking. Muscles are induced to act irregularly, some ligaments are stretched while others are relaxed, and the whole long framework of the foot is weakened. The muscles of the calf that are attached to the os calcis, or bone of the heel, are relaxed, and act at a considerable disadvantage, while the muscles on the front of the foot and leg are elongated and weakened. The astragalus, or bone of the foot that enters immediately into the formation of the ankle joint, is thrown somewhat forwards, and the ankle joint itself is thereby greatly weakened. For these and other reasons, sprained ankles and ungainly limbs are very commonly associated with the wearing of these needless appendages to the boot. Moreover, the heel being elevated, the foot is pressed forward into the toe of the shoe, the toes are apt to become crushed up, and a curving of the toe-nails is not infrequently induced. These evils are augmented when the heel is placed—as it often is—far forwards on the sole of the boot. In this advanced position it will be found to be placed just beneath the arch of the foot, and by its presence in that site it not only weakens the pedal curve, but also deprives it of its action as a spring to modify shocks transmitted through the sole of the lower extremity. As Dr. Buck well expresses it, a heel in this position has the same effect as has a block of wood when placed under the springs of a carriage.

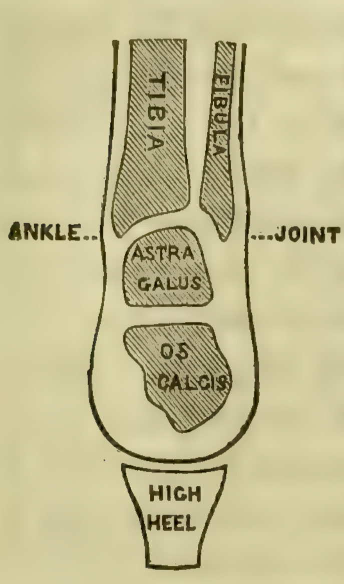

Fig 14.—Transverse Section of Foot.

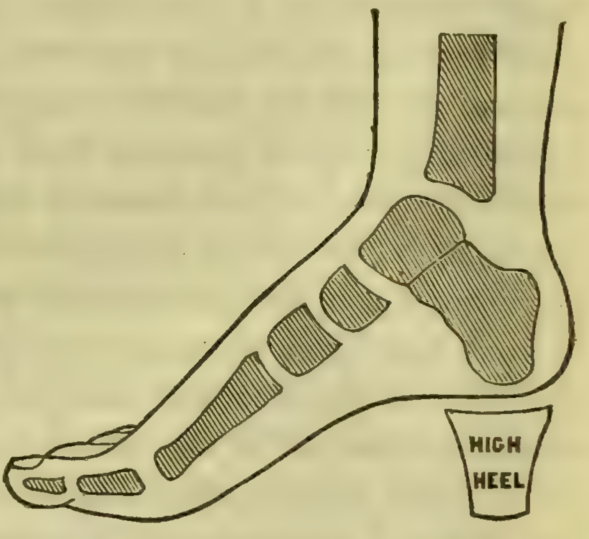

Fig. 15.—Longitudinal Section of Foot.

High heels are dangerous not only on account of the general instability that they give to the foot, but also by their weakening effects upon the muscles of the limb and the connections of the ankle joint. Their small size, moreover, renders them liable to trip up the individual, and not a few serious accidents have been ascribed to these fashionable impedimenta. A graceful carriage is inconsistent with very high heels, although by long and patient practice women attain a fair degree of proficiency in the almost acrobatic feat of walking upon their tilted shoes.

As to the comparative merits of *boots and shoes*, I think it may be asserted that, under ordinary conditions, the shoe is more consistent with a perfectly healthy condition of the foot. The foot, like the rest of the surface of the body, perspires, and often this perspiration is free. It is desirable, as has been already explained, that this perspiration should be allowed to evaporate, or, in other words, to escape. Leather being practically impervious to moisture, will prevent the proper evaporation from the skin if the foot be entirely enveloped in that material. The foot requires to be ventilated, and in the shoe that object is more easy of accomplishment than it is in the boot. When the foot is covered with a boot, the only chance of the air gaining access to the skin is afforded by the loose connections of the boot about the ankle, or by any open space in the line of the lace or buttons. Boots have been made with especial apertures for ventilation, but such arrangements are, for the most part, very incomplete. Shoes have the additional advantages of leaving the ankle free, and of being considerably less in weight than are ordinary boots. It is significant that the foot covering adopted by those engaged in vigorous exercise takes usually the form of the shoe, and thus we have "cricketing shoes," "running shoes," "lawn-tennis shoes," and the like.

It is said that shoes may lead to a weakening of the ankle, while, on the other hand, we hear frequently of tightly-laced boots as excellent means of strengthening that joint. Assuming that the bones are sound, the integrity of the ankle joint is maintained by the muscles and ligaments about it. A weak ankle means enfeebled muscles or relaxed ligaments: a strong ankle implies vigorous muscles and stout ligaments. If muscles are weak they can only be strengthened again by proper exercise, while the vigour of ligaments is maintained by a constant and proper use. The worst treatment, therefore, that can be adopted for a weak ankle is to enclose it in a high, tightly-laced boot. Such a practice tends to exercise the muscles still less than they were before exercised, and the rigid boot taking the place of the ligaments to a great extent, offers no opportunity to those structures for a more complete development. Dr. Humphrey, speaking of this practice, remarks that it "has its parallel in the idea of strengthening the waist by stays. The notion is in both instances fortified by the fact that those persons who have been accustomed to the pressure, either upon the ankle or the waist, feel a want of it when it is removed, and are uncomfortable without it. They forget that the feeling of want has been engendered by the appliance." Children are, unfortunately, the chief victims of this mistaken treatment of weak ankles, and I can fully endorse the statement that "there can be no surer way of producing permanently weak ankles than by lacing them up tightly during childhood, and so preventing the natural development of their ligaments.*

THE DRESS OF INFANCY AND CHILDHOOD.

The general principles that have been already laid down with regard to a proper covering for the body for adults apply equally to the circumstances of the young.

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* *British and Foreign Medico-Chirurgical Review*, 1862, p. 123.

There are certain conditions, however, incident to childhood that render the dress of this period of life a matter for special consideration.

1. Infants require to be clothed warmly; not that the temperature of the body in extreme youth is below that of the adult, but because in very early life the heat-producing powers of the organism are feeble, and therefore proper clothing is needed to prevent undue waste of such animal heat as is generated. For the first-year or so of life this lack of vigour in the heat-producing powers of the body is obvious, and young children have therefore the same need of warmth in their clothing as have those still younger. There is a somewhat prevalent notion that by clothing children lightly, and by exposing them at an early period to cold, they become accustomed to fluctuations of temperature, and are, to use the term of the advocates of the practice, properly "hardened." The hardening process, it is perhaps needless to say, is a delusion and a snare, and is accountable for no small contribution to infant mortality. On the other hand, scarcely less objection is to be taken to the plan of "coddling" children up, and of keeping them at all times in the atmosphere of a hot-house. The point to be aimed at is the maintenance of an equable temperature about the child's body, a temperature that will avoid extremes, and be free from abrupt fluctuations.

For reasons that have been already given, some woollen material should be worn next to the skin, and, owing to the sensitiveness of the integument of quite young children, it is desirable that the fabric used should be of the finest possible texture.

2. The body should be perfectly and evenly covered with clothing. This point has been already insisted upon in dealing with the attire of adults. In infants and children it is a point very constantly ignored. On examining the ordinary dress of an infant, it will be found that round the abdomen and back are several closely applied layers of flannel, in the form of what is known as a "binder," while the neck and shoulders are covered but partially with some linen garments, and the arms are quite bare. To complete the system of the unequal distribution of clothing, a vast amount of totally superfluous and ornamental material is clustered about the lower extremities of the victim. In older children, moreover, while the body is perhaps properly covered, the neck, arms, and legs are left bare, and thus every inducement is offered for an unequal distribution of blood and an irregular circulation. These defects in attire are not difficult to remedy. It would be well if the infant's garments were lessened in number and made so as to cover the body in a less fragmentary manner, while for older children it would be not unreasonable to require a covering for the legs and arms at least as complete as that that pertains to adult dress. The infant's head should be kept cool. At birth the skull-bones are very thin, and in parts defective, and the covering provided for the brain is therefore comparatively slight. Thus it happens that the circulation within the skull is more readily modified by external conditions of temperature than it is in adult life. The system of enveloping the head in flannel, or of allowing the head to bury itself in a feather pillow, tends to draw more blood to the part than is necessary or perhaps comfortable; and the ridiculous helmet-like hats that are often inflicted upon infants when out of doors are simply barbarous, not only from their warmth, but from their weight and the pressure they may exercise upon the scalp.

3. The clothing should be free from constrictions of all kinds. In the first place, exception must be taken to the "binder" that is commonly worn by infants during the first few months or even years of their existence. Until the fragment of the umbilical cord has separated, some light bandage round the body is desirable; but the object of tightly encircling the body for some eighteen months with several layers of flannel is totally unintelligible. This article of clothing helps to maintain an unequal distribution of animal heat; it must be applied tightly or it will slip, and thus it acts as a constriction upon a part of the body that should be kept quite free. By superseding to some extent the action of the abdominal muscles, the binder must hinder the proper development of those muscles, and may lead to the development of an unduly pendulous abdomen. The colic of young infants is, I imagine, often due to causes in which the binder takes no insignificant share.

Children's garments should be loose, and should exercise undue pressure upon no part. Dr. Lewis Smith has recorded the case of a young infant who is supposed to have died from embarrassed respiration due to too tight clothing.* If constriction be bad for adults, it must be infinitely worse for the young, for those whose bodies are in active growth, whose tissues are delicate, and whose bones are but imperfectly solidified.

At the same time, it is desirable to avoid the other extreme; and it should be borne in mind that a child may be clad too loosely. This especially applies to the looseness of children's clothes about the neck. So loose are the under garments and dress that it is often possible to see the entire length of a child's back by simply drawing back the clothes at the neck. This very free admission of air to the integument is rather more lavish than is desirable, and often involves certain additional garments in order that the child may be kept warm.

4. Under no circumstances should any garments be attached to the waist. Any constriction of the waist of a growing child is nothing less than a barbarity. The dress, the petticoats, &c., should be supported by proper means from the shoulders, or be attached to some loose bodice that descends as low down as the waist.

5. The garments of children should be as few in number and as light in weight as is consistent with a proper protection of the body. The attire of a young infant is usually a serious offence against this proposition. It is enveloped in a number of garments, some insignificant in size and others of extravagant proportions. It is weighed down by robes and elaborately decorated gowns, and on special occasions is encumbered with a cloak containing enough material to clothe the shoulders of the nurse who carries it.

The remedies available for these and other defects in juvenile dress are matters of common sense merely, and their adoption would undoubtedly add some comfort to the apparently troubled existence of a young child.

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* "Diseases of Infancy and Childhood." London, 1881, p. 69.

THE INFLUENCE OF OUR SURROUNDINGS ON HEALTH.

By James E. Pollock, M.D., F.R.C.P.,

Consulting Physician to the Hospital for Consumption, Brompton.

Introductory—External Influences—The Nervous System—The Senses and their Organs—Professions and Callings—Relief in Variety of Brain Work—Mental Strain—Retirement from Business—Life in Town and Country—Sleep—Dreams—Causes and Preventers of Sleep—Sleep-promoting Drugs—The Health of the Community—Sewage Arrangements—The State of the Public Health—Intemperance—Employment of Women—Competitive Examinations—The Practical Rules of Health.

Nature of our Surroundings.

The surroundings of a man are those influences, material or immaterial, which form the atmosphere in which he lives, which give colour to his daily life, and, often themselves unseen, are present with him for good or evil throughout the whole term of his existence.

As he is composed of body and soul, so the agents which affect him are material and immaterial—the one evident to his faculties of sense, the other appreciable only by the inner consciousness, yet both powerful in their results on his physical life.

We have, therefore, to consider two sets of agents always in action which influence man's condition, and we must also describe the mode by which they act on his organisation.

It is this double, or as some say triple, composition of every man—body and soul, or body, soul, and spirit—wrought into a living unity which renders him not only the subject of so many influences, but brings it to pass that you cannot affect one portion of him alone, the whole being responding to whatever influence is brought to bear on him, whether it be primarily directed to his body or to his soul. Agents purely physical, as heat and cold, thus become psychical in their effects, while emotions, and all which disturbs the soul's life or manifestations, react on the body, and exalt or depress its powers. This complex being, man, is momentarily the recipient of influences which affect the organisation which we have called life—affect it, that is, in its two portions, and one cannot feel or suffer without the other.

The common conditions of bodily health are, no doubt, primarily most influenced by physical causes, such as air, climate, food, and dress; but unless the man be very low in the scale of humanity, the other, or immaterial, plays a prominent part in his well-being or the reverse.

Besides influences bearing on our merely physical condition, life and health are largely acted on by agents immaterial or psychical. The lives and well-being of nations and individuals owe their colouring to these. They belong to, and form part of, civilisation. The savage feels them scarcely at all, but they are essential parts of the education from which springs the character of a people. Higher education results in the elaboration of such agents, and although they are not its primary effects, yet they are not the less potent in influencing the results, and even the duration of our existence. Man is a compound being, each part of which must be nourished in order to be healthy. Such agents are called psychical as are addressed to the soul. The manifestations of soul are seen in our emotions and higher aspirations, in our sense that we are part of the infinite, although with finite bodies in which we temporarily reside, but from which we must part.

Our appreciation of the infinite and of the meaning and problem of our life belongs to this soul, and on it many impalpable agents act, and through it on the body.

Were bodily requisites alone supplied, man would vegetate; but as he is subject to evil influences from without, so is he to good. Evil surroundings depress, lower, exhaust, and reduce him to the level of lower animals. His animal part may survive the deprivation of soul influences, but morally he yields to the lower passions, which stifle the soul and engender bodily diseases. The predominance of passion over will, the yielding body and scarcely resisting spirit, tend downwards, and doubtless man would descend in the animal scale were his bodily appetites to predominate for successive generations, just as he has gone up in the scale as civilisation and moral training have advanced.

But influences come from without, and reach us through the senses. It is not sufficient for man to be told from books or by teachers what is beautiful or noble. He must be approached by the senses, and the sight and hearing, even the touch and smell, are capable of influences of great importance to the growth of man's moral nature, and to its ennobling. It is for this reason the surroundings of a man affect and alter his nature and his happiness.

Again, each individual man stands the living representative of hereditary antecedents and of national peculiarities. These are the result of climate, government, and of varied social conditions; but individually he is the subject of all the influences which have helped to form his family or his race.

The form of governments, their freedom or tyranny, liberal institutions, or misrule restricting social life, narrowing the field of intellectual occupation, compelling youth to serfdom or to celibacy, forbidding knowledge to enter the land, and limiting education, influence the intellect and the spirit of a people, whose physical condition invariably degenerates under such misrule. Mental and moral depravement coincide with bodily degradation, and courage decays with honesty. The elements of national character and of national greatness are found associated with bodily health and vigour, or rather the latter seem dependent on the former.

This question of the elements of the power of various races is so large that it can only be hinted at here, but illustrations abound in the history of nations. The decay and fall of the Roman power was preceded by the enervating influences of luxury at home. When wealth increased at the capital, and the vices which it engenders pervaded all classes from the Emperor to the slave, when foreign mercenaries were sent to fight the battles of the Empire, and the youths were no longer trained to arms, the invincibility of Rome ceased, and she fell a victim to successive invasions of hardy northerners. With effeminate vices came bodily decay and cowardice. Or to come nearer to our own time : look at the Spanish race, once powerful and invincible. With the conquest of South America came luxury, greed of gold, cruelty and lust; and now represented in their own colonies by a mixed race of Indians and Spaniards, they have in those colonies degenerated physically and mentally, and are incapable of sustained efforts either for war or peace. Compare this race with the Germans, who are full of young life and nationality—mentally and bodily vigorous.

A comparison of the natives of Hindostan with Europeans is very familiar to ourselves. The causes, it will be said, are complex, and include climate as well as government; but we may say that the race is of inferior stature, deficient in muscular and nerve power, as compared to the European, and that the causes are to be found in centuries of tyrannous rule, the limits of caste, and the prevalence of effeminate habits in a hot and moist climate. The native Indian life is of shorter duration, and is so regarded by the English insurance companies.

Compare Turkey with England or the United States, or modern Italy under the Popes with "Italia Libera." The influences of climate can hardly fail to strike as shaping the character and temperament of race. The "hardy northern" is a proverbial expression, and all history testifies to the more robust frames, the higher courage, and the superiority of mental vigour in the races who inhabit temperate climates. This may be seen in our Norse and Danish ancestors, and in the power and intelligence of the Normans.

Even at the present day, the northern part of France and Italy are inhabited by people of superior energy to those of the south. Piedmont and Naples, Normandy and Languedoc, serve as illustrations. Our own English climate, which has no extremes, although much abused, produces, in our judgment, as fine a race for vigour of body and mental energy as any in the world. Their powers of endurance have been shown in their ability to carry their victorious arms into any climate. The Indian mutiny was crushed by a handful of English troops in the height of summer. Havelock's and Colin Campbell's marches were undertaken under a tropical sun; while our endurance of cold has been equally tested in our Afghan wars.

Many other agents, which are promoters of national character, are to be found in scenery—mountains, rivers, lakes, extensive plains, and the ocean; and the peculiarities so caused even tinge the individual members of a nation or people. Thus the dwellers among mountains, as the Swiss and Scotch, are enthusiastic lovers of home, and when they emigrate are subject to home-sickness or *nostalgia.* They are essentially patriotic, and the Swiss especially, who are great emigrants, return with their earnings, made in distant capitals, to some remote and bleak mountain-side in their own country.

The inhabitants of plains are less enthusiastic and less nomadic, while the dweller by the ocean is a wanderer.

We have indicated some of the causes of the vigour and greatness, and of the weakness and decay of nations and races, because no man stands alone, or can be considered merely as a unit, representing in himself the influences which surround him personally. Every individual is the representative of generations of national peculiarities and of hereditary antecedents. We all think we can tell an American, a Frenchman, or an Irishman at a glance, even before his talk betrays him; and doubtless there is a colouring caught from others, often subtle and indescribable, not visually present. As various animals possess the colour or form of the stones or leaves among which they dwell—as the crocodile resembles the riverside rocks among which he basks, many serpents the leaves in which they lurk, the grasshopper and innumerable insects the colour of that on which they feed, so man bears the stamp of his race and country. The traveller sees whole peoples having to his eye the same features, and wonders—not remembering that he himself is also marked.

Now, the individual is subject to the influences of all the causes which have helped to form his family or his race—if not actually and personally, by hereditary descent. He is a member of a tree nourished by invisible sap, often of remote origin, and supplied from a distant source. He is a link in a long chain, of which he knows neither the beginning nor the end. The form and shape of that link, its defects or strength, he is personally only partially responsible for; other influences than his, the vices, the follies, the strength, or weakness, and all the surroundings of his ancestors have modified this individual, who boasts of his free will and independence. Free he is, but ever guided by the impressed character of those who have preceded him; the invisible rein of their accumulated power or weakness is round his neck; and though he stands, as it were, localised, he has unseen connections, and he represents in himself the results of many causes. In addition to inherited proclivities, he is also capable of transmitting that which shall colour the health, the temperament, the very life of his successors.

In considering the influence of our surroundings, we must regard man as he is—not a mere unit, capable of being moulded and altered by circumstances, but as a finished compound of many national and ancestral peculiarities, which may become modified by his individual experience, and which he will, more or less strongly, transmit to those who are to succeed him.

Man, then, is the recipient of numerous external influences acting on his body and his spirit, and his sensibility to their action is primarily modified by his position as a member of a nation and of a family whose characteristics he inevitably represents. The savage and the civilised European are differently acted on by the same events, and identical circumstances do not always produce the same results.

We introduce a savage Zulu to our great city, our arsenals, factories, and palaces; but it would be thoughtless and unreasonable to expect him to be affected in the same manner as, or even to observe with the powers of, a cultivated Russian sent to study our civilisation and arts. Physical events have a more powerful influence on the former, and immaterial or psychical on the latter. The civilised and educated man has a wider range of observation and of thought; nature and art mould or alter him, raise or lower him, affect the tone of his moral life, and add to or diminish his physical enjoyment and the health of his body. He is a mere sensitive instrument reflecting the changes of nature. The progress of knowledge and of art, and all surroundings affecting his mind or his body, are felt more actively and produce more palpable results the more highly he has cultivated the arts of civilisation.

How do external influences act? They approach man through his nervous system, of which his senses—touch, smell, sight, hearing, and taste—are the exponents. They are the recipients of so many messages sent from the outer world to the individual inside. Outward influences pass along the nerves to the nerve centres—brain, and spinal cord—the fibres conveying the message being called "afferent," while the reply is flashed along an "efferent" line from the centre to the surface. Suppose the message sent up to be an injury or distress, joy, or pleasing emotion. The return sent back to the surface, in the latter case, is seen in the blush, the glistening eye, tears, the necessity for exercise. The excitement is reflected, so that man desires muscular activity—he runs, rows, "works it off." No one sits down to reflect when sudden good fortune is announced, the task accomplished, the prize awarded, success achieved. Life rendered joyous when we are still young expresses itself in activity. Man feels expanded, the world is too small, space too confined for his boundless joy. All senses are enlarged in activity and power by joy, victory, success.

So also we are "knocked down" by grief, by a sudden shock, by bad news—well described as a "blow." It stuns, and we reel—are prostrated by the loss of a friend, or fortune, or hopes. Muscular activity is annihilated; we "sit down" under it; the attitude of grief is shown crouched—often prostrate—the head falls on the hands. Not the erect attitude with which young hope enters on life, buoyant and elastic; but the beaten-down shrinking to earth: "I am troubled, I am bowed down greatly," said David.

And then grief is reflected on others. When a royal lady and her child died at the birth in England, almost within our time, a like event occurred to many mothers and children throughout the country.

The mechanism by which this is accomplished is the nervous system. This is not to be confused with the vulgar idea of the "fancy" or imagination. A person is called "nervous" who is influenced readily by the emotions, and gives up that control of the will which is bestowed on us to master our feelings.

The nervous system is as real and demonstrable a part of the body as are the muscles or bones. For our purpose it is sufficient to describe it as consisting of an infinite number of fibres or filaments, extended over every part of the body, and especially on its surface, collecting and forwarding messages to a common centre—the brain and spinal cord—from whence a return current or message is instantly despatched back to the same or other points, which declares itself as a sensation or something we feel, or confers movement. Feeling and motion are the two main results of the nerve message and the reply. The central office—where the *power* which presides is always resident, ready to receive and reply—is divided off for convenience of action (as in great public offices) into compartments, each of which has a limited and defined duty, and to this converge the filaments, which for convenience are called "afferent" or "efferent," as they carry to or from the centres. We have not yet been able to localise all these parts, and to assign to each its exact rôle; but we know many of them with precision, and our knowledge has of course resulted from experience gained from living animals as well as from our observations of the effects of injury and disease on certain parts of the brain. It is satisfactory to know that this knowledge is increasing daily, owing to the observations and experiments of skilled observers. Thus we know the part which governs the rendering our thoughts into words, for any injury to the part will instantly result in an inability to speak with correctness, although the vocal powers remain perfect.

A cut or a blow on the head sends up to the sentient part a message of injury, and pain is felt as the reply.

A nauseous, perhaps poisonous, article is taken in the mouth, and instantly expelled. Here, again, a message has been sent.

Or a fly has entered the eye, and a sudden flow of tears washes it away; this exemplifies another action of the nerve centres; it influences secretion.

Many instances of this may be observed. The Indians give a man accused of a crime some rice to chew. If guilty, and deserving punishment, he has no saliva, and spits it out dry! The secretion of milk is well known to be influenced by fear, sorrow, or violent emotion of any kind. The child at the breast has been known to have died from the effect of passion in the mother, which has turned the milk to poison.

The secretion of bile is dependent on nerve action which governs the chemical and vital energies concerned in its production. It has been suspended by grief and terror.

Tears, or the secretion from a small gland in the corner of the eye, are the ready expression of violent emotion, be it of joy, or sorrow, or fear.

The action of the kidney is notably increased by fear or anxiety. The skin, which has an extended surface, studded with millions of glands producing sweat, is very markedly under the influence of terror or any undue excitement of the passions. The terminal blood-vessels of the skin, as indeed are the blood-vessels of the whole body, are capable of expansion or contraction by the influence of what are called vaso-motor nerves. The supply of blood is limited or increased under their influence, and the pallor of fear, or the flush of anger, or the blush of self-consciousness in its many forms are the result. In all this we see the result of a governing power in the nerve centres—brain and spinal cord—acting on the terminal nerve filaments of the body, which are constantly receiving impressions from without and transmitting them to the interior. We are thus momentarily under the influence of outward events, which are registered within, and become, as it were, part of ourselves, being indeed factors in most of our feelings and motives, and secondarily in the activity and vigour of our organs. If man were a mere machine which, fed with chemicals, or supplied with motive power from without, would continue to act with uniformity, the term of his life would be merely a mechanical problem, easily solved by a calculation of the necessary and uniform wear and tear of the machinery.

That he is more than this we all know, and we shall next consider how his special senses act, and afterwards those agents and conditions which, for want of a better term, we must call psychical, and which influence the power and energy and results of every vital phenomenon.

The surface of the body, then, is covered with a network of sensitive nerves, which convey to the nerve centres—brain and spinal cord—the information which contact with physical bodies has originated. Thus the sensations of density, heat, and cold are communicated to an observing power within. And so the special senses of sight and hearing are occupied at all times, except during sleep, in sending observations which reveal the outer world to the inner centre.

The organs of sight, though double, act as a rule unitedly where the vision is perfect, and the focus of the two eyes must be alike.

The nerves of sight (optic), as is well known, cross at the back, the right sending filaments to the left, and *vice versa*, and certain fibres crossing from one to the other, their unity of action being thus secured. But the destruction of one eye does not prevent perfect sight with the other, as each is governed by a separate part of the brain.

The organs of hearing are differently arranged. They are double, and distinct in action. There is no structural connection between the two; no interlacement of nerve fibres as in the case of the eyes, and the two ears can act separately or unitedly. There is, doubtless, a central governing power by which the hearing of both can be directed to the observation of a single sound, but in point of fact the ears are ordinarily engaged singly and differently. By a set of beautiful experiments, it was ascertained some time since that when an individual with unimpaired powers of hearing is within range of several dissimilar sounds, all those of a like character are listened to by one ear only, while the second ear is engaged in hearing such as are different from the first. Thus one ear listens to conversation while the other is occupied in taking note of the passing train, or the street organ, or church clock; both being at work because the sounds are unlike. In a silent room, if both ears be placed by a tube in connection with several watches which are going, all the watches click into one ear only, while the other is either idle or listening to some distant sound. The two ears are, in fact, like the starboard and larboard engines of certain steamers, and can act separately or unitedly.

On the other hand, when both ears are brought to bear on the same sound, the power of hearing is doubled. This is well seen by using a double stethoscope to examine the human chest, the breath and heart sounds being greatly magnified when both ears are engaged. It has been noticed, however, that while the sound is intensified, it is, perhaps, less defined, so that a single ear is the most accurate observer of sounds.

Thus man is formed to see the distant, even beyond measurement in the case of stars, and, by the exquisite adjusting power of the eye, to enjoy the near landscape or the microscopical feathers of the wing of a moth; while his ears can appreciate at one time the most varied sounds—music, for example, with all its enchantments, delighting the soul at the same moment when the second ear sits as a watchful guardian to warn of approaching danger or to take note of innumerable minor surroundings.

On the exercise of these two senses depend the most exquisite of our enjoyments. As we go through the world, or sit alone in our chambers, all that is beautiful and sublime passes in review before us, nature in its countless forms, art in its unending variety, adding the charm of ideal colouring to the actual. The magnificence of mountain, sea, and river, the solemnity of forest depths, the sublimity of the ocean, the more human charm of what we call picturesque, are conveyed to us and enter our souls through the senses, influencing man's life and strengthening, consoling, humbling, and ennobling him as he passes through the varied lot of his existence. In the struggle of a strong passion, and in the hours when decision has to be made influencing the flood of his life, man flies to nature—"makes him friends of mountains, the stars, and the quick spirit of the universe," and while he is subdued is strengthened in their presence. No one can doubt that he is influenced by such surroundings, and we only do not know how because the results are as varied as are the phases of individual character. Yet these things all act through the senses; the converging results of such wide-spread agents enter the soul through the eye and the ear. Is it any wonder that "the eye is not satisfied with seeing nor the ear filled with hearing"? The soul absorbs and reflects and assimilates the countless products of nature and art which so enter it, but "man cannot utter it." The result is formation of character, and all which we call life is impressed, but few indeed can render back into visible form of words the influences from without which have made man what he is.

Only we do know that in times of mental depression, or in the exhaustion following severe illness, he is refreshed and strengthened by such; and while we attribute the daily recovery of body and mental power to change of air, we know that other subtle but powerful agents from without are more potent still than the sea breeze or bracing mountain air which we have recommended.

The calming influence of music is well known from the time of Saul. It is now used in like cases, and in our asylums it is noticed that the patient who can play on an instrument or sing is uniformly less violent, and more under control, than the man who has "no music in his soul." The effects of plaintive strains will be remembered in the well-known instance of melancholia and suicide prevailing among a Highland regiment in a remote foreign station, when "Farewell to Lochaber" was daily played by the band. The wise colonel put a stop to it, and substituted cheerful music, and the disorder ceased. In our hospitals music is now found to be a powerful adjunct to the treatment of chronic cases of disease. At the Hospital for Consumption, for the last fifteen years, weekly musical entertainments have been given, varied by dramatic and literary readings, and occasionally by a lively farce. The effect has been very manifest in the increased cheerfulness and well-being of the patients; and it is remarkable that during these performances there is scarcely any coughing to be heard.

The sense of touch ministers to our wants, is our guardian against injury, and conveys impressions which assist all the other senses. It is thus a secondary agent, ever waiting on them. The smooth pillow inclines to sleep, as indeed does a hard couch if it be even. It is noticeable that many persons touch the flower which they admire, even though it is not to be plucked, as in a rare collection of exotics. To such it certainly increases the enjoyment. We gather information as to form and outline, and our pleasure in viewing many beautiful objects at hand is increased by absolute contact. Thus the dog or the bird we admire is caressed, and human objects are pressed to the heart. How the prisoner within bars has pined for the embrace of his wife or child, just seen but not permitted within reach!

In blindness, this sense replaces sight, and is intensified in delicacy. It is wonderful how practice can cultivate it, while the physician has often occasion to test its impairment in order to identify certain disorders of the nerve centres. Its increase by practice is seen in the power of dealers in silk and other fabrics to detect the various qualities simply by touch. So, too, in the cases of the violin-player, and the surgeon, whose eye is said to be in the ends of his fingers! The exaltation of this sense—that is, its increased sensibility—is often an indication of brain disease, while its temporary annihilation by various anæsthetics permits us to perform painless operations.

Viewed as a medium of conveying outside impressions to the inner man, it is active at all times except during sleep; but while its integrity is a necessary part of sound health, it is certainly secondary to the other senses in influencing the life and health of an individual.

And so of taste, which is but an active source of pleasure or pain. Among the most wonderful functions of the human body is that power of discriminating an infinite variety of substances which we call taste. This sense surpasses that of any other in delicacy; perhaps on this account the name is applied to a minute discrimination of the beautiful in colour and art, and a refined taste is ascribed only to the cultivated possessor of the rarest powers of appreciating the beautiful. By the taste (in its primitive meaning), we can decide on the minutest differences of flavour in everything which possesses it even slightly. All kinds of flesh, fowl, fish, the innumerable varieties of fruits and vegetables, are instantly recognised by this test.

Sweet and sour are but coarse illustrations of the palate power. The exceedingly minute differences in varieties of tea and wine, which the "taster" in these trades can point out, is truly wonderful. We have seen half-a-dozen vintages of claret and port discriminated one after another by a wine-merchant, to whom they were presented quite unexpectedly, away from his home. Taste and smell go together, and doubtless both were in play, but no chemistry could analyse, and no language could describe in words, the exquisite differences of flavour which the palate can detect. The great wine years 1844-1848, and so on, appear to have each manufactured a subtle essence, which, years later, was distinctively characteristic of the growth of that year. That this sense ministers to our enjoyment and to our health is undoubted. That its cultivation may lead to excess is only to say that all over-excited senses make us sensuous, and prone to the indulgence of that which by practice we have brought to perfection. The highly-trained ear, the frequently-used palate, have the run of intensified pleasures; but feebleness and exhaustion result from their excessive use, and the calm will must control the passion and storm of the senses. In considering our life and our health we must begin with the fundamental rule that all excess is to be avoided as a peril, while moderate exercise of functions strengthens the power of organs.

The sense of taste is closely associated with that of smell. The two act together, and by suspending the one the other is for the time nearly lost. Thus the nauseous taste of drugs is prevented by holding the nose. Our relish for certain kinds of food depends quite as much on their smell as on their taste. Yet although associated, the two senses have a different nerve supply, which is, however, spread out on a continuous mucous surface.

The memory of certain scents, and our association of them with past scenes or events, or with individuals, is a curious fact in their study. We are instantly recalled to long-distant times or places, or to the presence of a friend, by the subtle and invisible scent of a flower or perfume. Certain persons habitually use one scent, as musk or patchouli, but they should remember that their presence is ever afterwards associated with the scent. By it they are recalled when absent, and heralded when they approach us. They are also often credited with having some disagreeable odour to conceal. Those who are wise will use perfumes but rarely, and vary the kind. The sense of faintness which some odours cause in many persons is also notable.

In Italy and other southern countries, flowers are not permitted in the sick-room. Here we have no such custom, and our hospitals are now commonly decorated in summer with beautiful flowers, which greatly minister to the happiness of the patients, and we have never known any evil result from their being so used. It is not only their beauty and odour which give pleasure, but their association with other things and places—the cottage home, or the scene where joyous hours have been passed. The "language of flowers" is intelligible to all, and we have noticed in hospitals that those blossoms which afford most pleasure are not the cultivated exotics, but rather the violet, the primrose, and other spring flowers, by which the imagination is drawn from present surroundings to the copse and homely garden, the spring in the wood, and field walks by the scented hedge. Wild flowers are indeed the most elegant decorations which we can import into our towns, and it is pleasant to see that they are being more brought into use. Their value is due not only to their beauty, but to a thousand exquisite associations with the country. The taste is not confined to the educated and refined, but evidently comes home to the hearts of many dwellers in close courts and grimy homes, where we are often startled to meet with this evidence of the love of nature. We are inclined to believe that the love of country life is a most universally diffused taste, shared by the roughest and even by the criminal classes, who prefer roaming over the country and sleeping under hedges—the life of the tramp to the life of the town. The outpouring of the lowest classes in London into Kent for the hop-picking, where they camp out along the hedges for several weeks, undergoing many privations and much exposure to weather, illustrates this, but is beside our subject. It is also beside our purpose to do more than notice the sentiment which man has at all times attached to flowers, and there is no doubt their perfume has much to do with it, although their form and colour may be the chief attraction. It were poor work, too, and idle to analyse the *modus operandi* of the poet's dream and the lover's fond hallucination, to whom the "whole world is filled with odours" when his lady love wears his flower on her breast!

Professions and Callings.

The influence of occupations on our life and health is very evident. We almost fancy we can detect the calling of a man in his manner, and by the "look of him" pronounce beforehand on his profession. There are many individuals of original cast of mind who escape this, but with the mass it holds true. The habit of thought begets an outward manner, just as the constrained position at the desk often imposes a permanent posture. In these days of more abundant athletic exercises this is less observable. No doubt we all carry about with us, whether or no it be perceptible to ourselves, the stamp of that which is our life's occupation. We can even tell the man who has no occupation. Before considering the effect of mental work let us briefly regard classes.

The Church.—The clerical life in town is decidedly a busy one, and the whole day is often passed in self-denying devotion to the cause of the poor and the uneducated, in holding meetings and mission services, in advocating temperance, and superintending the reading-room and coffee shop, and by word and example in humanising the most difficult element in English society—the working class. On the other hand, the rural clergy pass an easier life, which is one of mental content with the routine duties of daily life duly performed, and the pressure of parochial work is rarely great.

In the case of both town and country clergy there is, or ought to be, little money anxiety. Clergymen live on a small but secured income. No extraordinary hospitality or show is required of them. They are on a social level with the highest in the county, but they need not entertain. If they have escaped the misery of college debts they should not undergo the harass of paying for past enjoyments out of present necessities. The family has no need for extravagance, and the great pressure on the father comes only when his children have to be educated. It is difficult to manage, but somehow it is done; and the sons go out into life and win their way in all professions, while the daughters, without the temptations to fashionable extravagance, have the tastes and manners of educated ladies, and often marry well.

We have sketched this picture because the clergy are the most healthy class of the community. They live longest, and the annals of clerical Life Offices amply prove this. We attribute their longevity to comparative ease of mind and of circumstances, the "neither poverty nor riches" of Solomon, to daily sufficient but not harassing occupation, to exceptionally temperate and moderate habits, and to the practice of being much in the open air.

The Bar.—With the Bar we have to consider the influence of the struggle and wear and tear of competitive life. The battle has to be fought with the strong amid surroundings not tending to produce health or longevity. In this profession it is generally a case of "the survival of the fittest," and the fitness consists in a good constitution, which can contend against crowded courts, much confinement to the desk, late hours, and often heavy dinners and full living. The day has to be passed in continued mental activity, and a fair meal is often only obtainable at a very late hour.

It is only human nature to make that meal a full one. Loss of sleep by devoting many hours of the night to a preparation for the next day's work is inevitable to a rising junior or to a successful Q.C. Thus the morning finds him full of his subject, but with a tension of the nervous system which only prolonged repose, not then obtainable, can restore. With a fair amount of sleep a great quantity of head-work can be done without injury, but "kind nature's sweet restorer" is a necessity for such repair. Food, too, in reasonable quantities and taken at the proper time is of absolute importance to a man who is working his brain.

The effects of crowded courts and bad air seem to be as much complained of by judges as by the bar and the public, and certainly we have not as yet arrived at a satisfactory solution of the problem of having frequently-changed fresh air without drafts. As it stands now, the health of the practising barrister, although vastly improved by larger chambers, more exercise, and more moderate habits, is not comparable with that of the country clergyman.

It is the wear and tear of the nervous system, the harass and worry of life, and the incidental errors of diet and hours, which tell in exhausting vital power. Fair work does not kill any man, but when the brain powers are so taxed, and above all if anxiety be added to the continuous pressure of intellectual exertions, then the system suffers and exhaustion results.

The man who is anxious is never at rest. Anxiety means that the mind is perceiving more than the particular study on which it is engaged. There is a duality of mental occupation. The anxiety may result from money or home troubles—the sick wife, the impending engagements, the chance, which means uncertainty, a phase of thought ill-tolerated by an earnest spirit. These things, often revealed to the eye of the "faithful and far-seeing" physician, form the wear and tear of life, and it is only the strong and somewhat callous who can bear them, or squeeze through life without losing some portion of health through their agency.

Medicine.—Closely akin to the Bar is the medical profession. Both professions are recruited from the class which has to win its way in life; for of course we exclude from consideration those briefless barristers who have chosen the law as a gentlemanly calling, but having good private means do not propose to practise. They belong to a different class, of which we may have more to say.

The medical profession is not long-lived. Apart from the inherent dangers of the calling—exposure to contagion and poisoning from infected wounds, which cut off many more than the public has any idea of—their surroundings combine, perhaps, more of the elements which are pernicious to health than any other calling. Anxiety, arising from the difficulty of starting in life; the supposed necessity for keeping up an appearance, especially in early days; the harass of a family to be maintained and brought up; for it is supposed that young practitioners should be married, and they do generally marry early in life: these, and the struggle against competition, always great, are serious considerations indeed. Perhaps nothing tells more on a man's nervous system, and certainly nothing is more complained of, than the being constantly "at call;" the necessity for being always ready day and night to rouse up and apply his best powers to some case more or less urgent. It is to be remembered that every case presented to the medical mind demands his entire judgment, and calls into play a wide range of knowledge. Cases have all what we may call "individuality," and cannot be dealt with on wholesale principles, as a merchant or broker deals with well-known and daily-repeated transactions. The medical man is expected to be always at his best; his knowledge must be at his fingers' ends, and mistakes may be fatal alike to his patient and to his own reputation. His sleep and meals are daily broken in upon; his time is not his own, and there is an inherent selfishness or egotism in every one who is ill, which exacts from his attendant the very opposite condition, or self-negation. This is trying when prolonged through the best years of life. The rewards, also, are not large except to the few. It is hard-earned bread, and the fee or compensation is often grudged, and the bill well criticised and often reduced. The public are, on the whole, liberal to medical men, but there are many instances of grinding hardship which are felt but never expressed by the practitioner. Above and outside of all this there is the gratuitous work, from which no medical man ever turns away, and of which every man has his share, from the humble village practitioner to the London physician who obtains an honorary hospital appointment after severe competition, and is thenceforth the servant of the poor. The public know little of this work. The out-patient department of hospitals is officered by young men, the *élite* of our universities and schools, each of whom spends generally for three days in the week the best hours of the day, seeing from one hundred to two hundred patients, who enter his room one after the other, and receive careful consideration; each case is examined and noted and prescribed for; and all this, continued for ten of the best years of the young physician's life, is unpaid work!

True, it is said: "But the physician thereby acquires experience, skill, tact, and knowledge of diseases!" So it is; but the wear and tear is immense. And when the skilled prescriber returns to his home in the evening, without having earned a guinea, he is tired enough, and often tempted to say "cui bono?" Yet two hours later you will meet the same man at some medical society, perhaps reading a paper, the result of hundreds of observations at the hospital, or ready to discuss that of some other member with impartial mind. Here again, as at the Bar, it is the "fittest who survive." Many disappear from the profession while still young, to adopt some other calling, or, having started with ambitious hopes of success in London, are compelled to choose some humbler walk in practice, perhaps in the country, or abroad. All the well-known foreign places of resort for invalids are filled with "sick doctors," who are compelled for health's sake to live away from home. Great examples of longevity there are, it is true, as in the case of the late Father of the Profession, and others known to us, whose mental activity continued in spite of advanced years. These are men who have had their early trials too, and have not shrunk from the work of life.

And here it is well to ask the question, whether mental activity tends to shorten life by engendering diseases of the brain? And also another question which arises out of former—whether retirement from active professional life into country leisure has proved a success?

The first may be answered in the negative. The brain which has been fairly worked lasts longest, just as all other organs of the body. Wasted muscles are the result of inactivity, and so are wasted brains. The centre of the nervous system is stimulated by an increased circulation of blood, and while in activity the nutrition of the part is more full and complete, and its powers are proportionally sustained. It is the period of inaction which is to be dreaded, for it is a period of less nutrition and of consequent degeneration.

So far as medical knowledge goes, most disorders of the brain are caused by alteration in the blood supply. The structure of brain is singularly inert, slow to inflame after injuries, and very slow to undergo changes from time or wear and tear. It shrinks somewhat in extreme old age; but maintains its powers in a truly wonderful manner if one condition be fulfilled—that is, if its blood supply be perfect. It is the degeneration of blood-vessels in the brain which causes most of its diseases—softening, apoplexy, paralysis. These delicate, elastic vessels become thickened, hardened, rendered inelastic by age, and degenerate; that is, healthy tissue is replaced by fat, gouty deposits—even bone—which destroy the elasticity of the vessels, and render them brittle. Hence, the blood supply to the brain is interfered with, and a certain stagnant condition is induced; or a rupture takes place, or softening, and blood is poured out and causes pressure and loss of power. But this is a disease of blood-vessels which are found in the same state in other parts of the body, and not a disease of brain.

Now, if a healthy circulation in the brain means brain power, and if each mental exertion implies increased circulation and increased nutrition of the brain structure, it follows that a due exercise of intellectual power ministers to the health and to the enduring capacity of that organ. The characteristics of age are dulness of sensibility, and impairment of memory, of sight, and of all senses. All of these are brain attributes, and by working them the machine will be prevented for a long time from getting "rusty." There is no reason why the brain should wear out in a hundred years if its blood-vessels hold out, and certainly we have noble and encouraging examples of intellectual power in many aged persons.

A temperate, subdued, but constant activity of brain is certainly a promoter of long life.

It is very noticeable how many powerful minds find relief from mental fatigue in variety of brain occupation. To this fact, indeed, we owe some of the best of our literature. It is very intelligible how the change in our mental work tells. Sameness begets weariness, and possibly means that a single part of the great nerve centre is being constantly employed. We know that by the repeated performance of any brain function its powers are increased. Thus, memory is capable of cultivation to a high degree. The power of attention, which is akin to it, and of which it is indeed a part, offers another familiar illustration. Some people cannot give anybody a fair hearing; they seem lost in what we call dreaminess, and wander off from the subject before them. Early habit and long practice confer that which is so charming in social life—the power of listening to others, with perfect perception of their meaning, or, if that be obscure, of what they desire to express. This power is very capable of cultivation, and it is remarkable that it may be enlarged at pleasure, for many a barrister or physician, whose name and practice depends on an accurate attention to details placed before him, is absent in manner when the business hours are over. This seems beside our subject, but we use it in illustration of our proposition that separate powers of the brain are capable of independent use and cultivation, and that this seems to explain how the exercise of other functions may relieve those which have been so employed as to cause weariness.

The more distant from each other in the intellectual range these diverging pursuits of mind may be, the greater the relief, as when the Prime Minister flies from Irish politics to Homer! Contributions to general literature have of late become much more frequent from the busiest men in the various professions, and doubtless these men find great mental relief in change of thought, and feel that the tension of professional life is proportionately relaxed. The public demand for information rather than dogma from the learned has helped forward a movement in favour of reading the opinions of the skilled in medicine, law, and art in popular language, and thus has opened the door to many familiar and able writings in our reviews on subjects which were once confined to professional works.

The habit of hearing both sides has also materially increased the quantity of modern literary work, and called into the field of argument men who would not otherwise have spoken out, or, having written, would not have condescended to a justification or reply. Thus a varied exercise of brain power is developed and encouraged, and, if our view be correct, it is not an additional expenditure of energy or waste of nerve material, but by its variety exercises in turn a number of powers, and increases the vitality and working capacity of the whole mind.

The influences of sameness of occupation—sameness of thought, a similar expenditure of energy day by day devoted to work so like yesterday's in character that it is almost as the block turned out by machinery, an exact counterpart of that last made—cause the mind to grow old, and accelerate bodily decay, and gradually reduce a man's powers to the exact equivalent of the daily task which he has set himself to do. This condition is often submitted to the physician as a disorder. The mind wakes up to an examination of its own capacity, and seems at times to take stock of what it can do, and is surprised to find that certain things are no longer possible which were formerly easy. The tendency of men to get into a groove and follow in their business a routine method, instead of making their day's work an exercise of many mental powers, and the absence of any second and different field of thought, minister to this; mere slothfulness, and the desire to get through the day's business at a comparatively slight cost of exertion are, of course, at the root of it. An able practical man once said: "No one would work if not compelled to it." This is true of immense numbers of people, and to counteract this tendency it is well for every man to have a second pursuit to fall back on, even if it be simply athletic exercise of body.

MENTAL STRAIN.

We have spoken of brain activity, and the necessity for its maintenance, if we are to preserve our powers; and these remarks apply to the greater number of people who are more apt to be injured by inertia than by over-activity. But there remains a large class who undergo mental strain, or a want of adaptation of brain power to the work to be done; the latter is either excessive in quantity, or its nature is not suited to the capacity of the worker.

As the "surroundings" of a man consist in his occupation and its nature, in the mode and method of his employment, in the cares which waylay, and in the joys which recompense him, so we must include in the list that which also clogs and depresses, and often drags him down. The state called mental strain is very familiar to physicians. It may be in itself only a sign of disturbed function, or the machine may have broken down in some part, and the mischief be already done before a remedy is sought. Inadequate powers, or more work attempted than can be achieved, react on the nervous system, and first disturb some of its most refined functions.

Perhaps over-sensibility is one of the earliest symptoms. That which did not offend before, or which was tolerated as one of the inevitable accompaniments of business relations with one's fellows, becomes a source of annoyance. In our intercourse in life, in all the ordinary dealings where man meets his fellow, we are accustomed to encounter persons more or less troublesome—it may be vain, vulgar, or intrusive. The wise man goes on his way without taking offence, or showing a too refined sensitiveness. For heads of business houses this is a necessity, and the tact which eludes the troublesome and vain is in daily requisition. And so in every department of life where man meets man there is a preservative power and balance of temper which is exercised without thought, and costs us little exertion.

But there comes a time when trifles such as these rise into importance—they remain just the same, but we have changed. We cannot tolerate slight mistakes, the little peculiarities of others which may be thrust in our way, or even any slight interference with our own routine. We find ourselves taking offence where none was intended; we are testy where formerly prudent and forbearing, and trivial matters distress and annoy us. A singular feature in all this is that the individual perceives it himself, and the discovery adds to his annoyance, and he is thus rendered more irritable.

This irritability is in our experience of cases the first evident sign of mental strain. The balance of the temper has become disturbed, and we are restless and dissatisfied.

With this state, or quickly following it, comes loss of sleep. Either the sufferer cannot get off to sleep, or, having had a couple of hours repose, he wakes suddenly, and many disagreeable thoughts instantly intrude themselves, and generally in an exaggerated form. The events of the past day are vividly depicted, and minutest details are rehearsed in false colours. Past and apparently forgotten events also appear in ghastly form, and the mind takes but little cognisance of the actual and true counterbalancing facts which, were he in broad day, would instantly suggest themselves, and probably put quite a different aspect on his affairs. But for the time he sees through a glass darkly, and will not be comforted. The morning finds him peevish and out of appetite, and when he goes down to his place of business his temper is perhaps not equal to the events of the day.

During the day his appetite is capricious. Sometimes he eats ravenously, at others puts off his mid-day meal because he is not hungry, and he returns to his home in the evening unfed and more irritable than when he left it.

This is a perilous time also for another reason, for the temptation to take a stimulant is now very great. The unnerved state in which he finds himself is immediately and completely (for the time) relieved by a glass of brandy, and if he takes it once he is likely to take it again. Unfortunately it leaves him more irritable than he was before, as soon as the stimulant effects have worn off. He now takes stimulants instead of food, and attempts to go on with his work. His digestion gets impaired, and he imagines that this is the cause of all the evil, and has generally had a strong dose or two before he calls on the physician. But such remedies only relieve and cannot cure him. The true remedy is rest and properly-adjusted habits, and should such not be adopted he will get into a state characterised by still more serious symptoms. He will have a dull weight on the head which prevents him thinking, and failure of memory. He will have forgotten some important appointment or business transaction, or the letter which he has written or was to write, and some of his transactions are confused in his mind with others.

This altered condition of mind is exhibited not only in his business, but also at home, and is a weariness to his wife and family; or should he be a bachelor, his housekeeper informs you confidentially that Mr. —— is "not himself."

Another symptom distressing to the sufferer is shakiness. He feels uncertain of himself, and his handwriting is shaky. "I went down to the counting-house and could not write my name," said a merchant once whom we visited in the city. We were not surprised to hear a few days later that he failed. We shall not describe other and more advanced symptoms of mental strain, for it might tend to alarm sensitive readers, but that which we have described is often followed by evidence that a certain tract of brain has lost its power of receiving and transmitting messages. Even so, however, this state is capable of recovery, and we have seen a man whose power of speech was gone completely restored. Under these circumstances, the following considerations present themselves to us: "Is the game worth the candle?" Can the consumption of the best powers of life be compensated by any amount of gain, be it name, position, fortune? Not only is the condition we have described in itself perilous, but it may be the means of setting up habits of intemperance, and permanent ill-health, which mar the gains, the honours, and every enjoyment of life. The very capacity for perceiving and enjoying what is most eligible is wrung from one's grasp while we are putting forth anxious hands to secure it. Of course the person who has reached this stage has ceased to regard the situation with open eye, and to see it as others see it. Hence its great peril. Argument indeed is often thrown away, but a vigorous, earnest effort can be made to save; and here the physician or the friend often steps in with power. There is no remedy for such a state of things but rest. A prolonged absence from the worry of life must be secured.

The causes will, of course, vary with the profession or calling on which so much labour has been bestowed. Overwork stands at the head of the list. It means more work than the brain can do and remain healthy. Unfortunately the individual does not always see, and certainly is little inclined to pause when he is overworked.

Let us take "business," and first speak of the "heads." It is not uncommon in this country for the heads of prosperous firms to have emerged from the obscurity of clerkship by their own energy, an acquired knowledge of business, and above all by integrity and singleness of purpose. A combination of these qualities is unpurchasable, and is sure to meet its reward. But when headship is attained, and the confidential clerk or manager of a department is taken into partnership, his responsibilities are increased, and anxiety is added to his daily task. On the occasion of such junior partner being entrusted with a share in the concern, the senior will naturally feel himself relieved from some pressure, and begin to do less. In our experience the man who is most overworked and most likely to break down is the junior. He has more of the drudgery of the house, more responsibility as to details, and in order that the senior may rest he takes a shorter holiday. With a diminished holiday he also has longer hours, and the anxiety of new responsibility often presses heavily upon him.

We need scarcely enumerate the other causes which weigh on heads of mercantile firms. It seems to us, regarding the question from an entirely medical point of view, and only as it has been revealed to us in medical practice, that the causes for anxiety have multiplied in late years. The old-fashioned merchant who imported goods and sold them through a broker no longer exists. He has become a speculator in all kinds of stocks. He is no longer a simple trader, but has all kinds of irons in the fire, and many of them, too, at the greatest distance, and beyond his control or powers of management. He is a railway contractor, a coffee grower, a maker of tramways, an electric-light contractor, but much less of an importer of goods than he was. If you ask him he will tell you that the telegraph has spoiled the markets, and that the good old days of fortunes made in silk or cotton are at an end, and that he must find new investments for his money. This may be true, but with this change an enormous amount of responsibility and a new field of worry has been added to his life. No man could possibly possess the knowledge to qualify him for such diverse undertakings, and he must therefore be necessarily in the hands of others more experienced. Here, then, is a new source of anxiety. So long as he managed a single business he was in a measure his own master and his own pilot, but now he has to trust to others on matters of which he knows himself to be an insufficient judge.

We can testify to this being a frequent cause of mental strain. If any distrust of those to whom these varied enterprises are committed creeps in, how wide a door is opened for sleepless anxiety!

To have indicated this is sufficient for our purpose; our informed readers will fill in the picture for themselves.

The holiday question comes in here. In our time we have somewhat improved by shortening the hours of labour, but many counting-houses are kept open too late under the excuse of mail days, balancing, &c. The half-holiday on Saturdays and the four bank holidays are a great boon to busy clerks and shopmen. But they ought to be extended. Above all, there should be a reasonable holiday in the middle of the year, for the purpose of visiting parents and friends, settling private affairs, and refreshing mind and body by a sojourn among natural objects. The shopman is even worse off; his hours of confinement are longer, and his place of business is generally less healthy than that of the clerk. While we recognise with pleasure the great improvements which the large London houses have made in providing for the lodgings and comforts of their shopmen of late years, and in almost every instance their great liberality to them when sick, we must protest against the short holidays. Health might be economised and life made happier, and, as a sequence, better work would be done by giving two holidays instead of one. We are aware that other considerations beside health enter into this question, but having a rather extended experience of this clsss we feel bound to speak strongly from the medical point of view.

There are other classes affected by long hours—from the member of Parliament to the humblest drudge at the desk. The night sittings in the House of Commons have not been very productive of late, and legislation cannot be said to have improved in proportion to the length of time devoted to it.

The stealing of the night hours for work instead of repose is very pernicious to health, and may bring on all the evils we have been describing. The surroundings of a man cannot be said to be good when he is deprived of necessary sleep, and men who have been the most intelligent observers of these things have decided that loss of rest is among the evil agents which sap the foundation of health. We shall, therefore, by and by consider the question of sleep.

Retirement from Business.

The second question, whether retiring from active life as age advances has answered the expectations of those who have tried it, depends on what retirement means. If it implies giving up the struggle of life for money or honors, abandoning the hard grind of the daily routine of the counting-house or shop, or of professional practice, which does not always exact our best from us, but requires an abject attention to the matter of the hour, and leaves no time for calm thought or favorite study, or even for the duties and affectionate intercourse of domestic life, it may be well. But if we have no substitute, no hobby, no intellectual occupation, no resource to fall back on but an empty leisure, then it is evil. It has failed a hundred times to confer the pleasure expected, and it will fail a thousand times more. To retire at once from active life and to do nothing is simply to anticipate old age, and its feebleness and degeneration will creep in on us unawares. The man who has been accustomed to keep his attention awake at all times to the business of the day, when he retires to the country, unless he has something more than the outward surroundings of a pretty place to occupy him, becomes stagnant, disheartened, disappointed, and many have gone back to the busy city unable to bear the sense of mental emptiness which their rural dream has realised for them. But not all; many have found in their age leisure for new studies or old favourite ones revived, and the immense field of physical and moral science has found earnest workers in the aged; or history, poetry, literature have well supplied the place of hard professional work, and both student and subject have been enriched. As a rule, it is the practical, active man who cannot retire. Sir Astley Cooper came back, if we mistake not, within a year; and others have tried the experiment with a like result. Repose of mind, or its freedom from daily calls made on it by the demands of others, is the just reward of years of early life passed in the activity of the professions; but the brain must be given occupation to replace that which has been withdrawn. If that new direction be pointed to a review of the larger interests of life, if we were all as we grow old to write an impartial record of our experiences, even a true story of our own lives, it would be invaluable to others and a fitting exercise for ourselves. It is rarely done, and so experience dies out and is lost, each man having, in a sort, to begin it again for himself, and so the world advances more slowly than it might do. Or if age, which is, or ought to be, free from the passions and prejudices of life, were to assign to itself as a task the advancement of any single line of knowledge, in even the smallest degree, and if this had been the practice of the educated in all time, how the world would have advanced and how human learning would have accumulated! As it is, we draw on a few monographs for our records of experience, and are travelling painfully enough over ground which has already been trodden by many who have studied and gathered results, but left nothing for their successors.

A man of course may retire into the country, or be equally a retired man in London. The intellectual man will probably seek the latter, as he will find there more readily the surroundings of books, society, clubs, and amusements; or he will travel. As the latter subject has been considered in a separate article, we shall only allude to it as one of the most agreeable and healthy of our resources, if we combine with it a study of the varieties of nature or art, which we find in other countries, or explore their libraries, and, especially, if we can interchange thought with their great men.

The influence of town life as compared with country is no longer what it was in the days of our fathers and before railways. It must be a very remote place in which we do not receive our London news at an early hour of the day, and in it find chronicled an abstract of telegraphic information from all parts of the world.

Dwellings are quite as healthy in great towns as they are in the country, and have even better sanitary appliances. But the air is different. In great manufacturing towns it is charged with impurities, and even in the west end of London is perceptibly less fresh and exhilarating than in the country. It is also charged with smoke, effluvia "from drains" and dustbins, and the detritus, wet or dry, of the great traffic which is constantly whirling along. The air passages in a man living in London contain always a perceptible quantity of dark or slaty coloured grit. Fortunately they are furnished with a delicate ciliated velvet pile or coat, which by gentle action, like that of the wind passing over a field of ripe corn, throws off impurities, which become mixed with the natural secretion of the part. We are often consulted about the expectoration of such slaty matters. There is no doubt that the whole body is at a lower average of strength in towns than in the country. There is less vigour, partly due to a more partial action of muscle. We exercise our legs only in London, our arms scarcely at all.

The influence of town habits, varying with the demands of fashion or occupation, is very various on different persons; but they will be found to resolve themselves practically into the effects on the body of the mode of living, as regards exercise, food, dress, and sleep.

SLEEP.

"Half our days we pass in the shadow of the earth, and the brother of death extracteth a third part of our lives!" says Browne.

We seem familiar with the phenomenon of sleep, and recognise it as a necessity of our existence. Without it life would be weariness and exhaustion—nay, could not last long. Shakespeare calls it "chief nourisher at life's feast," and the great master had doubtless a true estimate of what it does for the human body. It is, like food, a nourisher and a repairer of waste. All the wear and tear of the day, the weariness (which means wear) of mind and body, which our various occupations have caused, are remedied by this great pause in our lives. We have passed a day of bodily fatigue, or else of mental occupation; we lie down, and rise refreshed and renewed; sleep has "knitted up the ravelled sleeve of care;" we have forgotten the misery or loss, the tired muscles feel fitted for another day's labour, and we meet the world with new powers and fresh resolves; and so "man goeth forth to his work again until the evening."

This is all very plain to us; but perhaps we have never considered what sleep is, and what it does for us. Many able minds have, however, thought it out for us, from the days of the early Greek philosophers to the present time.

We shall not find it easy to define sleep except by saying that it is a temporary suspension of several bodily faculties; but we can show what it does. It is not a total suspension of any faculty, nor does the whole body sleep. That would be death, of which sleep has been called the "brother."

Sleep is a suspension of sensation and of volition. Certain senses and our will-power are for the time inactive. In other words, certain powers of the brain and nervous system cease, or nearly cease, to act. The rest is all awake—some say more awake. All the rest sleeps not. The spinal cord never sleeps; nor the nerve system so closely attached to it, which is called the "sympathetic." These two, which govern the automatic motions of the body, never rest. Were their action suspended for a moment, the heart would cease to beat and the lungs to expand; the blood would not circulate, and intestinal movements would stop. All the work of the machinery of the body would come, in fact, to a standstill, and that means death. What then does sleep? And how far does such inaction extend? The senses and the power of the will over muscles are mainly impaired by the temporary condition of sleep.

If you watch a man going to sleep in an upright position, you perceive perhaps, first, that he ceases to hear; then his sense of touch is lost, and he no longer feels the book in his hand; then the power of holding it is lost; the will no longer commands the muscles, so he drops it. His head droops, owing to the relaxation of certain muscles, and falls forward, calling a new and unaccustomed set into action, and this wakes him up suddenly. The senses of hearing, sight, touch, and smell are lost;

but not equally, or in exact proportion. Sleep, then, is not a single act, but a condition of unceasing change. It is a succession of states in constant variation not only of different degrees, in which the same sense is involved, but also in the different proportions in which the several powers are under its influence at the same time. Thus there is deep sleep and light sleep; the lulling of some senses, and the imperfect action of others. Each separate sense may be at the same moment in a different condition, even some awake and some asleep. Sense after sense goes, and, as Bichat says, "le sommeil géneral est l'ensemble des sommeils particuliers."

Sensation is, however, impaired, but not lost; and the will is suspended only for a time. Thus those who have most studied the subject regard sleep not as a unity of state, but as a series of fluctuating conditions of which no two moments are alike.

The soundest sleep may be said to be that with the greatest tranquillity of those bodily organs which are dependent on the will. It is, perhaps, this suspension of the will which is the greatest rest, the cessation of that voluntary exercise of power by which we govern both mind and body. Stop this, and we sleep ; fatigue this by prolonged exertion, and the whole system feels exhaustion. We can scarcely imagine that it is the senses of hearing, sight, and touch which undergo fatigue, for, as we see, they sleep partially, irregularly, and at intervals. It is this power which we call *will*—surrender that and we get rest. Maintain it in exercise and we only partially sleep. The use of nitrous oxide gas is familiar to most of us. It is analogous to sleep; were it to stop the automatic movements of the body it would cause death.

But meanwhile the fancy works. Memory and reason are disturbed, but the fancy is exalted to fantastic flights composed of visionary materials drawn from the past and made apparent to senses which are no longer in connection with the outer world. Hence the brain thinks in sleep that the eye is seeing, but that organ is closed. No voices but the imaginary speak in sleep to the auditory nerve, but the fancy paints it, and the will is lulled, and we believe that we see or hear the impossible.

Dreams, however, exert a great influence over many, and are assuredly part of the surroundings of our life. Some of the greatest minds have been most under their influence, and many who do not confess it even to themselves, much less to the busy world. Job says :—

> "In a dream, in a vision of the night,
> When deep sleep falleth upon men,
> In slumberings upon the bed:
> Then He openeth the ears of men,
> And sealeth their instruction."

Byron, again :—

> "——Sleep hath its own world
> And a wide realm of wild reality,
> And dreams in their development have breath,
> And tears and tortures, and the touch of joy:
> They leave a weight upon our waking thoughts;
> They take a weight from off our waking toils;

They do divide our being: they become
A portion of ourselves as of our time
And look like heralds of eternity:
They pass like spirits of the past—they speak
Like sibyls of the future: they have power—
The tyranny of pleasure and of pain:
They make us what we were not—what they will,
And shake us with the vision that's gone by—
The dread of vanished shadows—are they so?
Is not the past all shadow?"

But we need not multiply quotations to show the influence of dreams in causing sorrow, joy, or the various emotions of the heart. We would only notice that it is the emotions and not the reason which are commonly influenced, and this is exactly what we should expect from the suspension of the power of the will, which, during waking hours, preserves us from many mistakes into which the imagination would lead us.

Holland considers that all sleep is accompanied by dreams, whether we remember them or not, and that the deepest sleep is when there is absence of the consciousness of having dreams, although this does not render it certain that dreams have not existed. Brougham believed that we dream only during the time of transition into and out of sleep. It seems probable, however, that there is no part of sleep without dreams, although Bichat believed that "dreams are only a portion of the animal life escaped from the torpor in which the other portion is plunged."

Some suppose that dreaming depends on fluctuations in the circulation of blood in the brain, causing differences of pressure. We are all aware that nightmare and the most distressing kinds of dreams may be caused by indigestion.

To return. The object of sleep is repose of two great functions of the nervous system—sensibility and volition; and we are inclined to believe that the greatest amount of rest is obtained when no memory of having dreamed remains with us on waking.

Why are some dreams remembered and some forgotten? King Darius forgot his dream altogether, but was oppressed by the consciousness that he had dreamed, and his spirit was shaken although the cause was not manifest. We are all puzzled at times by a like cause. In sleep we have wandered off into far regions—conversed with the dead and dear ones—and have awoke to loneliness, but not to memory. The sense of having been, or having done somewhat, and then forgotten it, is worse even than those well-remembered griefs which visit us in the night season. "Can such things be, and overcome us like a summer cloud, without our special wonder?" Indeed Shakespeare has said, "we are such stuff as dreams are made of, and our little life is rounded with a sleep!"—signifying that at all times man has within him a mysterious soul element, which seems to run wild and elude both control and recollection when we sleep.

The only answer we can give to our question is that dreams are best remembered when the sleep is less perfect, and that some impressions are in themselves stronger than others.

The causes of sleep are various, but all act on the nervous system. Thus fatigue of body or mind, the exhaustion caused by pain or anxiety, watching through hours generally devoted to sleep, exhaustion by having recently experienced any strong impressions or emotions, are familiar to all.

Certain conditions of the blood itself, and certain states of the circulation, favour sleep. The blood which is more charged with carbon—less pure and less oxidised—possesses narcotic influence on the brain. Cold also in any extreme degree causes sleep, and it is well known that many a benighted traveller has been killed by yielding to sleep when fatigued and undergoing great reduction of temperature.

The action of narcotics and anæsthetics is familiar, the former producing torpor of the brain, the latter suspending sensation. Many substances of both classes first produce a species of intoxication or elevated sensibility before they lull the senses. It is this action and not the narcotic or sleep-producing effect which is sought by the opium eater or smoker. It has been well said that "no sleep is healthy but that from which we are easily aroused," and this is not the case with those who have taken narcotics.

Among the preventers of sleep may be noticed excessive mental exercise, extreme emotions, long-sustained anxiety on any subject deeply interesting to ourselves or involving our well-being or our passions. Thus business speculations and their uncertainties, the harass of most occupations, especially of several subjects pressing at the same time, drive away sleep. "Whenever I cannot sleep I leave town," said a well-known and hard-worked member of Parliament to us, and this is the case with many.

When we address ourselves to sleep the mind should be disengaged from any strong emotion or urgent train of thought, and even anxiety to sleep is often a preventer.

Indigestion causes inequality or disturbance of sleep. Digestion goes on during sleep, and alters impressions on the sensorium. It probably acts through the circulation, or, as some suppose, mechanically by pressure on the great blood-vessels behind the stomach. At all events we know that undigested food will cause a bad night. He that is to sleep well should feed lightly. The abuse of stimulants causes want of rest and bad and imperfect sleep, but a moderate stimulant—a glass of beer or wine, or a little brandy at bedtime—will often induce sleep in those who are habitually temperate.

Many plans have been recommended to procure the blessing of repose for those who cannot "lay them down in peace and sleep."

Exercise late is good. "After supper run a mile," and it is certainly not advisable to go direct from a hot sitting-room to a warm bedroom for the night. A turn out into the cool air is much more healthy, and often succeeds in procuring a quiet night. The bed should be firm and elastic—not feathers. In India, Europeans use a pillow for their knees to keep the bed cooler.

To procure sleep we have been advised to get up and walk about, to use the flesh-brush, and this will be found highly useful where a dry state of skin gives that restless feeling called "the fidgets." We have found total instantaneous immersion in a cold bath highly useful. The Chinese advise to wash the mouth with cold water; in India they tickle the soles of the feet. Boerhave recommends to listen to dropping water, also Spenser:

> "And more to lulle him in his slumber soft,
> A trickling streame from high rock tumbling downe,
> And ever-drizling raine upon the loft,
> Mixed with a murmuring winde, much like the sowne
> Of swarming bees, did cast him in a swowne."

Others advise the Æolean harp, while Æsclapiades used to be rocked asleep, and this certainly succeeds with infants, and seems to act on the circulation in the brain. Franklin advises a cold air bath, taken by walking about the room in one's night-dress, and this is very successful. Others put the feet in very warm water. Electricity has been recommended for this as for everything else.

Kant comes very near the mark when he advises to direct the thoughts to indifferent subjects—which means to take them from the grief or anxiety which keeps us awake. Artifices succeed either by exhausting attention, or by carrying the mind rapidly from one subject to another, but they often counteract sleep by promoting activity of mind. A desultory state without emotion is the most favourable to sleep, and if we have achieved that we are on the very edge of insensibility. By gently ringing the changes on our senses, touching the strings lightly, and flying off to another before the first is roused to complete attention, we attain that very gentle play of the nerves which quickly subsides into insensitiveness.

Regular hours of retiring must be considered as one of the best methods of securing good nights. The human body has a wonderful periodicity in all its spontaneous actions, and by studying these much of the machinery of health may be made to work smoothly. Witness our habit of waking at a certain hour to which we have been accustomed.

We are often consulted as to the best posture in sleep. It is perhaps a matter of indifference which side we select to lie on, but all are agreed that sleeping on the back is bad. "Sleep not on your back, or in the posture of a dead man," says Confucius and Hippocrates also.

In certain diseases the posture in bed is characteristic of the affection. The consumptive patient lies only on the healthy side. In pleurisy the *decubitus* is on the affected side. In heart disease it is commonly on the right side. In aneurism often on the face. In asthma the sick man lies high, his shoulders supported by pillows, while extreme breathlessness is perfectly intolerant of the recumbent posture. In fevers the prostrate condition on the back is of evil import.

Sleep after meals is often discussed. It seems peculiar to a certain stage of digestion; some fall asleep at table, and the expression "forty winks" signifies what most have observed—that even the shortest period of oblivion relieves. Homer mentions it of Nestor as a sign of his great age, and it is certainly commonly associated with advancing age. Galen allows the practice, and with him we are inclined to permit it. It certainly relieves a distressing feeling of malaise, and if it were good manners might be safely allowed. Tea is the best restorative on awakening, and the transition to perfect mental activity is very remarkable.

It will be seen from the above analysis of sleep how very necessary it is to us all, especially to those engaged in brain-work. The labourer has no need of incentives to rest; bodily fatigue has insured it for him. Were this remedy for sleeplessness within our reach at all times, we should need no other, and both the time and quantity of sleep may safely be left to him who has taxed his muscular powers. In our higher civilisation and with our artificial life it is different.

The quantity of sleep requisite varies with age and occupation and habit. The infant spends four-fifths of its time asleep. The old man "rises up at the voice of the bird." Young growing lads and lasses require a full allowance of rest, and are very intolerant of time stolen from sleep for study, or even for pleasure. They should have at least eight hours.

It is often asked what young people who have sat up at night and on into the day at a ball should do. Rigid fathers and mothers expect them to appear at the breakfast table at nine o'clock. But this is a grievous mistake. They should be allowed to sleep it out. We are far from advocating these late dances, but it is not wise to "burn the candle at both ends." Sleep is a necessity for the animal body, and if unusual exercise and unwonted demands on the hours usually devoted to sleep be made, the balance must be made up by extra rest, or the machine will suffer. Thus our girls will come down to a late lunch the next day rosy instead of appearing pale at an early breakfast.

It is also observable that one person requires more sleep than another. So that one rule cannot apply to all. Excess of sleep often depends on habits of self-indulgence. It is often observed in old age, when perhaps it can scarcely be called excess. But it does not belong to the active old age we have been speaking of, which, as a rule, rises early and sleeps fairly well for about six hours.

We have sufficiently indicated the nature, causes, and preventers of sleep to enable every one to judge of its importance for himself. The surroundings which best encourage it are the dwellings we live in; the quiet of the country rather than the roar of London. Our room of repose should be moderately spacious, its walls of subdued tint, with no violent colours of drapery or carpet; the light should be southern, and sunny in the day; the curtains dark enough to exclude the early sun. High-class engravings are better than the often forbidding portraits of past generations, whose faces may supply a study of character not somnolent in its effects. Airy landscapes, or the exquisite etchings of the day, or scenes which we have visited with pleasure abroad, or some good copy of a picture by Raphael or Correggio, may find a place. A few chosen books should be provided, for many must read before they go to rest. The bed should be small and not curtained, the mattrass a spring, the covering light. The swan's down "duvet" should be at hand for a cold night. Gas should never be permitted—only wax-lights sufficient for the purposes of the occupant. The fire-place should never be closed, the fire always laid ready to be lighted, and in winter it should always be lit, only not large. There is no ventilation equal to that provided by an open fire. The dressing-room should adjoin the bedroom, and in it a reclining bath should be always available with hot and cold water.

Each man for himself must lay to heart the mental causes which prevent sleep. The making haste to get rich lies at the root of most of these. While we are still young we fancy we can do anything—work all day, give up our nights to labour, and go next day into life with unimpaired powers, and as "all men think all men mortal but themselves," the thing is done daily in spite of advice. After a day passed in the worries of the courts, the counting-house, or the anxieties of professional life, sleep alone can restore the wasted powers. A holiday once a year, with letters and telegrams following us, will not counteract the evil effects of repeated loss of rest. One of our ablest and longest-lived judges described to us the wise provisions for sleep which he made at the busiest period of his life, when he was Attorney-General and had a seat in the House of Commons. He always secured six hours, taken when he could get them, sometimes from 10 P.M. to 2 A.M., and again from 7 A.M. to 9 A.M., or when engaged in the House at night he took the evening for repose. One of our most occupied accoucheurs also slept when he could seize the opportunity, frequently in the day, as he did not know what the night might demand of him. Work habitually done at hours which should be devoted to sleep without such compensation as this is generally badly done, and this argument would prevail with many if they were thoughtful. In connection with this, it is noticeable that it is not only a gradual wear and tear of the machine which we are to dread, but it is well known to physicians that persons who habitually break the laws of sleep make very bad recoveries from acute attacks, such as pneumonia. Their organs, in fact, are not in a condition to resist disease when nerve power is not recruited by repose.

We have not spoken of the treatment of sleeplessness which belongs especially to the province of the physician. We advise that no one should treat himself by drugs for this condition. Let him try first, if he will, all the means which we have indicated; let him study the causes which prevent sleep, and reduce his hours of brain-work while increasing bodily exercise. Let him try regulated meals, great moderation in stimulants and in smoking; let him use the cold bath and exercise at night; and if these fail, have recourse to his "doctor." There are drugs which quiet nervous irritability without narcotising, and in certain cases they may be used with advantage. But to be cast into a deep sleep by opium or chloral, or analogous drugs, should be left to the judgment and management of skilled hands. These are most unsafe agents, and have killed many who were ignorant of their cumulative powers. In using narcotics to procure sleep, it is to be remembered that the sufferer seeks only to have one effect of the drug, whereas all of the class have several consecutive actions on the system, which are generally hurtful to the merely sleepless. However, their use may be safely left to the medical attendant.

A word about the "slothfulness that casteth into a deep sleep." This is not physiological sleep, but the suspension, like it, of the will and certain of the senses. And the wise man adds, "love not sleep lest thou come to poverty." The will to work and enjoy, and the desire to exercise the highest faculties of the soul, are crushed down and eventually lost by idleness, and the senses become dulled to the higher enjoyments, and sink to the lower level of the animal. Fortunately such instances are rare in the present day, although the accumulated wealth of this great country offers many temptations.

THE HEALTH OF THE COMMUNITY.

Our limits forbid more than an outline notice of some of the more important improvements which have lengthened human life and diminished mortality, and in proportion lessened the sickness and suffering of individuals.

For while it is true that heat and cold, moisture and drought, atmospheric pressure, and the direction and force of winds, and all that is called climate, largely influence the health of a people, and even impress a character on their diseases, it is doubtful whether other agents, which are the direct result of crowding, and the introduction of pernicious matters into water and air, have not a greater effect. Hippocrates and Sydenham predicted from the nature of one season the diseases of the next, but we have always ailments among us of what are called the zymotic character—fevers, scarlatina, small-pox, and the like—which are predicable as the result of local insanitary conditions. It is fortunate for us that these last, which are of much greater importance, are more entirely within our reach than the former.

Has the health of the English community improved? is a primary question. We shall not burden the brief pages of an article intended for popular readers by figures, but call attention to results. First, we are free from the frightful epidemics of plague, sweating sickness, and others under different names by which our ancestors were infested and cities depopulated. These, although attributed to imported causes, were all fruit of the same seed which found in our insanitary habits a soil fit for their growth. When London was undrained, and cesspools lay under the houses, when the water was fouled and irregular in supply—surface water, in fact—no wonder that plague and disorders depending on ferment poisons introduced from without, were widely prevalent—prevalent, in fact, till they had slain all the susceptible. As regards this class of disease mortality has, no doubt, greatly diminished. There still remain among us typhoid and typhus, erysipelas and diphtheria and small-pox, and outbreaks of these or of scarlatina prove terribly fatal. But the mortality from them has considerably lessened, and measures are now at once adopted in neighbourhoods where they are prevalent to prevent their spread. Until, however, there be compulsory registration of all cases of infectious disease occurring in any place, whether among the rich or the poorer classes, and until the law authorises and enforces their isolation, and proper disinfecting measures to be adopted, we cannot hope for their extinction. It is most true that the worst centres of contagion are found among the lower classes, who are crowded together in close rooms, and the subjects of every insanitary influence; but the self-preservation of the rich depends on these unhealthy conditions of the poor being amended in the first instance. Some of our noblest houses in London are surrounded by poor dwellings, over-crowded and badly drained, and we cannot wonder if epidemics spread from the hovels at the back to the palaces in our squares and leading streets. The investigation of some of our well-known physicians, which led to the detection of milk impurities as a direct cause of introducing typhoid from infected localities in the country and London, have been attended by the best results, and individual cases occurring are now daily traced back to their origin in such causes.

The treatment of the sewage of towns, which is intimately connected with the purity of our rivers and water supply, is another improvement. The main drainage of London effected in our time is a gigantic work, which has doubtless diminished disease of that class which is promoted by stagnant water, or which depends on local emanations from sewage. Our water is also improved in quality, especially that which is drawn from the Thames, although much remains to be done while towns and villages higher up the stream are permitted to drain into it.

We are not yet fully informed as to the best mode of dealing with sewage matters, but their use in agriculture is undoubted, and if judiciously applied to land at a distance from dwellings can have but a small prejudicial influence on the health of a neighbourhood.

The ventilation of drains and soil pipes, which is now insisted on in all houses, is of vital importance to our health, and this has been dwelt on elsewhere in this work, while it has received the marked attention of some of our best workers in sanitary science. In our opinion the country farmer, and the agricultural labouring classes, have now more to dread from impurities escaping into their dwellings than have the inhabitants of towns.

Great improvements in the dwellings of the poorer classes in London have occurred within very recent times. New streets are being run through some of our worst localities, and great blocks of houses containing rooms for many hundreds are built up, which offer at a moderate rent well-ventilated and roomy accommodation. As yet these are insufficient in number to receive those who have been displaced by street improvements, but they are being daily increased, and are a step in the right direction.

The tendency of the labouring class to move out of central London into suburban parts is remarkable, and tends more to their health and well-being. Yet, even in spite of workmen's trains at a low rate, it is hard for a man to have to travel miles in the early morning before he can get to his employment. Yet, his own health and that of his children are vastly improved by the change. He finds in these new buildings drainage, air, and water better than he ever had before.

The protection to health and life which Government can afford to communities is of course limited, but much has been done by the aid of modern science.

There is first, of course, the police protection from violence, which is much more effective than in former days, and probably better than in any other country—certainly superior to most.

Enforced vaccination has, on the whole, been an enormous success, the proportion of deaths from small-pox among those so protected being represented by a fraction. The supposed introduction of other diseases by vaccination has not been supported by investigation, and a scientific committee appointed by one of our first medical societies to report on the subject found only the rarest instances of communicated disease.

The provisions for preventing the sale of impure or adulterated food are of the greatest gain to rich and poor. The poor man gets more for his money, and is tolerably secure against substitution of inferior or deleterious articles. The supervision of meat, bread, and fish, and the guarding of milk from adulteration, the cattle disease laws, and the general care of animals by preventing over-driving and cruelty of treatment, are regulations dictated by a wise forethought for the health of the people.

There are other diseases than small-pox against which legislation has been directed most wisely, as we think. Their discussion has given rise to various opinions, some of which are founded on a misapprehension of the legitimate functions of all governments and an undue estimate of their powers.

Laws are formed for the protection of the community from injury of all kinds, but it is no part of the function of governments to make people moral by compulsion. They seek that end by education, and by improving the social condition of the people; but no law can make or maintain morality in a people.

The care of infants and the prevention of infanticide by laws enforcing the registration of persons having charge of young children, and their frequent supervision, is an improvement, even if more be wanting.

The compulsory system of State education is yet on its trial. It must remain for another generation to see whether the results so ardently hoped for will be produced. Yet there can be little doubt that the status of whole classes will be elevated, that the power of education to afford greater means for advancing in life and for the progress of lower grades of society into the higher, will be made manifest. If it is not evident that the people will be made more moral by teaching, or their physical health raised to a higher standard, it is at least a fact known to us that, in the present condition of things, disease, misery and crime are found most prevalent among the ignorant, and it may be accepted as a truth that to raise the educational standard of a people is to improve their social state. Thus far we may go without arguing from imperfect data or drawing on the imagination to prove that what we desire is true.

The noblest aspirations of philanthropists are to make men pure and educated and healthy in mind and body, and we cannot believe that mental cultivation will not go a long way towards effecting this when whole classes shall have been permeated by the knowledge of God's laws and purpose, and of man's own history; of the struggles and social progress of nations, of that in which their real well-being consists, and of what are the true causes of poverty and man's failure. The study of natural science, of physical geography, of the causes of fertility of soil, of the events which regulate population, and a knowledge of the vast resources of other countries, of their adaptation for new fields of labour, and as an outlet for an ever-enlarging population at home, while it raises the character of a nation, will surely bring them more health and increase their longevity by securing their well-being.

"Fools perish for want of knowledge," and it is not Utopian to expect that a more extended appreciation of the natural laws which relate to health and disease will increase the material well-being of the community. At present there exists the most deplorable ignorance of these conditions, and errors prejudicial to health are prevalent among all classes. The knowledge of how and why men die, of the nature and causes of various diseases, and of the certain preventability of many, must precede their eradication from among us. We do not doubt that the time will arrive, although it may be distant, when, such things being well understood, and governments and people being united in effort and will, old age will remain the only "natural distemper"—as Galen called it.

The habits of thrift which have so large a relation to the health and happiness of a people have increased among us. Government has afforded facilities by the savings' bank at our post-offices, which shows a large annual increase, and by encouraging life assurance, which has been less of a success. In private life offices there is no doubt a considerable increase in the number of small insurers, and the facilities offered by many companies all over the country invite and cultivate saving habits. In France it is well known that Government Stock is held in small amounts by a very large number of peasant landowners, but it is only of late years that opportunities have been opened by the Government in this country to the poorer class to accept their security for loans. That poverty and unhealthiness go together is a daily observation, and it is only fair to enumerate thrift among the promoters of health. In like manner, the increased protection afforded to the property of married women is a helper to the well-being of the community. Whatever makes life and labour gains more secure becomes an agent in sanitary improvement. The mode of managing the great civil and military establishments of the Government has much improved in our times. The lodging and dress of soldiers is vastly better than it was; there is more space and air in their sleeping apartments, and their dress is much better adapted for the exigencies of the work they have to do.

In war the care of our soldiers is no longer what it was. His food is provided and carried on to the front, and no operation of importance can be proceeded with till supplies have been arranged for. So also his transport is now in roomy vessels, well-ventilated and provisioned. The hospital and ambulance system is now a necessary and costly part of every military expedition. And considering that sickness kills more than the enemy in time of war, the economy as well as humanity of this provision is evident. For our troops in India there is shorter and easier access to Europe, and more frequent change, and the practice of moving our forces successively into the most varied climates afforded by our extensive colonies has promoted their health and vigour.

If "peace," as Schlegel says, "is nothing but war kept under by human dexterity," and if an efficient and ever-ready force be one of its best means, everything which promotes the health and comforts of our army and navy must be of vast importance. And when war necessarily comes, the greater humanity of modern times mitigates the suffering of the combatants, while the recognised habit of respecting the rights of private persons in invaded countries reduces the necessary misery of such a struggle.

This is a large subject to deal with in a short review of those surroundings of our lives which act directly on our health and happiness. It has also been so largely discussed that the facts and opinions necessary to its elucidation are within everybody's reach.

If intemperance could be abolished the health of the people would instantly rise to a far higher standard, while crime would be proportionally lessened. Money would be saved, and ready for a thousand purposes, promoting the well-being of every one; homes would be happier by the removal of a fruitful source of discord, education would advance, our hospitals would be comparatively empty, and man might have a chance of rising to his right place in creation, and have his life indefinitely prolonged. It is not only the drinker who is ruined, but his family. His children are born with the seeds of inherited disease and feebleness of organs, and with scanty provision and constitutional weakness have to fight their way in life. Nothing is more hereditary than a tendency to drinking. It goes down from father to son, and nothing is more common than to see whole families in succession succumb to the fatal influence.

Drink not only muddles the brain of a man, but his bodily organs undergo degenerations which shorten his life, having given rise to intractable diseases of kidneys, liver, and heart. This is the fate of the habitual dram-drinker rather than of the occasional drunkard.

Among the upper classes there certainly is a much greater moderation observed than there was fifty years ago. But there is a large consumption of stimulants, especially by younger men throughout the day, in the form of drams, and it is right to state that this, in the opinion of medical men, is the most pernicious form of drinking. It is done at our railway stalls, and in many respectable-looking houses scattered throughout the city—wine-bars, bodegas, and the like—where the smallest quantity of every wine or spirit can be had. These are not "public-houses" which are frequented by a lower grade, but they catch numbers of young clerks sent out on messages.

The facilities given by the licences held by grocers to sell single bottles of spirits have greatly increased drinking habits among the more respectable class of women. They place the means within their reach which formerly were not so easy.

Against all this the medical profession daily protests. There is perfect unanimity on the question of temperance, and there is almost unanimity in the belief that the moderate use of stimulants does no harm as a rule, and may be beneficial in many cases of brain wear and tear, and in advancing age.

But there is no doubt whatever that the young and healthy are better without stimulants of any kind. The best work of mind and body is done without stimulants, and it is the duty of every head of a family to bring up his young children without their use. To ask the ungrown generation to make vows is, in our opinion, unfair, and likely to defeat its own purpose, but to train them to know that stimulants are not needful to life (as food is), and that the habit of using them may lead to an abuse which might produce the most serious injury to health and intellect, is a plain duty. Man can do without stimulants, and children should not have an artificial want inflicted on them.

To combat the intemperance of the day, especially among the lower classes, those means are most to be recommended which substitute wholesome amusements and recreation for the public-house.

Education, and the moral teaching of what is right, are largely assisted by providing for the working classes a place of resort in the evening where they may read, smoke, and have refreshments, music and books, in large and well-appointed rooms.

Occasional lectures of the lighter kind, but short and popular, are helps. The higher class of music has lately been introduced with great success. Good coffee-houses as well as large music-halls have great advantages, after all, over the public-houses, and might be made formidable rivals.

We do not believe in reformed drunkards. All experience contradicts the theory, and insurance offices reject it as an impossible event. No extra payment will induce any company to insure a man's life if he be, or have been, intemperate. This is an appalling fact, and it should sink into the minds of the thoughtless, as showing the merely money estimate of "drink."

Our dangers, then, are in excess. The moderate use of all things which advancing civilisation has placed within our reach tends to strengthen and prolong life. The richer we are, and the greater the abundance of superfluities which become easily obtainable, the stronger the temptation which lies in our way to abuse them. Lord Bacon has said, "the virtue of poverty is temperance—the virtue of adversity is fortitude." There are other virtues which poverty and the struggle for existence call into exercise. The poor often drink to "drown sorrow;" but Solomon's limit to the use of wine is not to be forgotten: "Give wine to him that is ready to perish." If a poor man is in distress and cast down by sickness or want of employment, the temptation to drink and forget for the time is strong. But it is destruction to yield to it, for it weakens at the very time when new strength should be sought for a struggle in another and perhaps more fortunate direction. The hopeful points in our modern awaking to the results of intemperance on communities seem to be the movements in self-governed bodies to restrict the sale of drink, and this has been done in many places east and west, from Russia to the Western States of America. In Ireland, Wales, and parts of the north of England, there is a strong effort in the same direction. And it is curious to note that the form which it has taken expresses a belief in the miserable weakness of character inherent in the drunkard. "Lessen the public-houses," they say, "and you will cause the decrease of intemperance," as if the thoughtless drinker could not pass on without entering such. "Surely in vain the net is spread in the sight of any bird," yet they enter and are caught. Let us hope, however, that this effort may be found to decrease our great national disgrace.

We advise every man to try, at least for a few months, how he can do without any stimulant whatever. He will soon find whether alcohol in any form be an essential to his health. If on trial he discovers that it is an essential part of his diet, let him resume it after consulting some impartial medical man who is not attached to either side of the temperance question.

When unusual mental or bodily fatigue has been undergone, or the hours of work been unduly prolonged, we counsel food and rest rather than stimulants. We have also, fortunately, a class of restoratives in tea and coffee, which retard bodily waste and repair nervous exhaustion to a remarkable degree. Those who have ascended high mountains, or traversed frozen Arctic regions, can testify to the restorative powers of tea, and we notice that a great General in preparing for our latest battle directed that the soldiers' tin bottles should be filled with tea.

Tobacco is another restorative which, if moderately used, soothes and restores exhausted nervous power, but it is not to be indulged in fasting, and can never take the place of food, although it takes off the craving of appetite. Its use has largely increased of late, and a different form of smoking has been introduced from Spain and America. The cigarette smoker inhales the smoke into his lungs, and it thereby obtains much more ready entrance to his blood, and is quickly absorbed, affecting the nervous system with much greater rapidity than when simply taken into the mouth. Tobacco is more injurious to the young and growing, and should not be permitted to boys. To men we may safely allow it in moderation, and to those engaged in prolonged exertion, as soldiers and sailors on active service, it is more than a comfort, and has helped many to endure privations. But we must not allow ourselves to be made its "slaves," nor permit its indulgence till our nerves are shaken and our digestion impaired by it. The little we have said on the subject explains that we class it among those agents whose moderate use may be permitted, but whose excess is injurious.

The taste for amusements of every kind has greatly increased of late years The old say that young men do not work so hard as they did in their early days, and this is true. There is more demand for leisure or holidays among all classes. Working hours are shorter, Parliament has limited the hours of labour, and our servants and employés ask for more frequent holidays. It is also true that less labour is done by each individual servant than formerly. Duties are more subdivided in our households and in our offices, and employers say with truth that they get less for their wages than they formerly did. This, no doubt, is one of the manifest results of increased prosperity. There is more demand for labour, and it is more difficult to obtain. Our colonies, India, and other countries, have come into competition with us, and every man has to-day a wider field of employment than he had fifty years ago. The nation is richer, the people have more comforts and better houses. They are better dressed and better educated, and many of the tastes formerly limited to the richer and well-born classes have spread into the lower and middle. The political reasons for this change it is not within our province to consider, but it is evidently the outgrowth of free trade and largely-increased facilities for travelling, of the intercourse of nations, of free communication of thought, of our modern railways, of improvements in the postal and telegraph services, of the enormous increase of books and readers, and of the cheapness of literature.

As people will amuse themselves, the means of doing so have multiplied. In London thirty years ago there were a few struggling theatres; now there are we know not how many, and they are almost always filled. Popular pieces are repeated two or three hundred times, and seats are hard to obtain. Crystal Palaces and places of outdoor amusements are numerous, and music-halls are found in every quarter. Good music is sure to command an audience, and we have now founded a college for the nation's instruction in this art, although till lately the English were thought to be unmusical as compared with foreign countries.

Athletic sports have also increased; the young men at our universities spend a good half of their time at it, and our girls are famous for lawn tennis. The influence of all this on our habits and health is undeniable. A greater amount of muscular exercise is common among all classes, and we believe that our youth are more healthy in consequence. Women especially are less constrained and less sedentary, and health is favoured by the more robust exercises now encouraged by fashion.

They are a set-off against the occasional extravagances of tight dresses, which are fortunately only ephemeral, and vary with the fashion of the hour. So long as we are at the mercy of the millinery trade of Paris, variations in costume will be of frequent introduction. It is a mere question of money, for even a graceful fashion in garments is speedily replaced by a different mode. The tendency to recur to that form which is most authorised by the opinions of all artistic people is, however, invariable. The Greek model of hair-dressing, as seen in their best sculpture, will probably be the most permanent, as it is the most elegant.

With greater tendency to athletic exercises it is noticeable that an extended freedom of manners, probably of American introduction, has crept in amongst us. The young seem to have started on a more independent line, and chaperonage is dispensed with at evening entertainments in many instances. Brothers and sisters may go anywhere together, and "mammas" may stay at home!

The increased intellectual independence of women, and their higher educational cultivation, is probably also answerable for their greater latitude of manners. It is only a natural result of the bold efforts which so many women are making to compete with man in the various professions and callings of life. This is not the place to discuss this great question, further than as it bears directly on the life and health of society.

There can be no doubt that in affording a wider range of employment to women we directly relieve the *ennui* and listlessness of female unmarried life. Physicians are well aware that to this compelled inertia many of the disorders of the sex are due. Women are gifted with a more highly sensitive nervous system than men. They are more affected by the emotions, and more susceptible to all influences from without. They have the organisation most adapted to a high appreciation of art; their delicacy of touch, and power of arrangement, and tactile skill make them the best instruments for innumerable manufacturing processes dependent on such powers. Hence, then, employment in our cotton factories, and in many of the more delicate departments of porcelain work. They have also quickness of appreciation, and rapid intelligence of the meaning of others. Thus certain details of business are best committed to their care. It is likely enough that partly as a result of want of hard intellectual training, and partly because they are the representatives of the hereditary idleness of their sex, they are less fitted than men for the exercise of the higher qualities of originating and deciding powers. They are thus less capable of inventing, and of such abstract processes of thought as qualify men for being at the head of political, or social, or business departments. Possibly, also, they are wanting in the equilibrium of nerve, and the passionless exercise of the reason, which have rendered so many men illustrious as leaders. But declining to judge the sex by its antecedents, because previous generations have carefully excluded them from all occupation which would train and cultivate their best faculties, there is still enough remaining power in female character to justify our committing to them the gravest concerns of life. Hitherto, indeed, they have justified the trust which has been reposed in them to such practical extent as it has been afforded. They are largely employed in our Government savings' bank and telegraph departments, and in several leading insurance offices; and have proved themselves good accountants, orderly, and punctual. According to our observation, the more recent occupation of women has strengthened and steadied character, has improved cheerfulness, and by training a habit of attention to facts and a control of emotion, has obviated many of those nerve storms to which the sex is liable. Deducting some instances in which too close confinement to offices and counting-houses has impaired health, just as it would do in men, we consider that a larger field of work for women has strengthened them constitutionally. Remunerated work takes away the wretched feeling of dependence on parents and other members of their families, themselves perhaps overburdened, and has helped to an elasticity of character, which is one of the elements of health.

Whether what are called the "learned professions" should be thrown open to women is questionable. Personally we are of opinion that women should be allowed to compete on equal terms with men, and to become lawyers or physicians if they are qualified by sufficient training and acquirements. That many would so enter if the door were thrown open we doubt, but we should open the door.

The other duties of women—domestic and social—are of a higher grade, and ought to be first performed; but there are thousands of educated women who will never incur the ties of wife or mother to whom free occupation would be a priceless boon, and on whom it would confer improved health and vigour.

Time will show whether these expectations are to be realised, but meanwhile women should receive an education qualifying them for a life of self-dependence, and the assent and approval of society should be extended to every exertion which they make to render themselves useful workers.

A few words should be said about "cramming," as it is called. Whether the competitive system has given us better men in civil life and in the services, we leave to others to decide. Military men seem to think that "blood"—that is, good descent—manliness, muscular vigour, and "pluck," are more valuable than book knowledge for an officer; but as it will scarcely be contended that a man can be too highly cultured for the higher branches of our civil departments, and for India especially, where the young "civil servant" very soon becomes a magistrate, or a political agent or administrator, and a representation in himself of European knowledge, ability, and character, we cannot train such men too highly.

But the mode of acquiring the knowledge which is to qualify a candidate for such a life is another thing. We believe that the best judges are agreed that slow learning is the most permanent and available for application hereafter. Knowledge which is "crammed"—that is, got up in a given time so as to permit of fair answering to an examiner—is evanescent and short-lived.

Of the effects, however, of such a system on health, there is no doubt. The brain is overstrained, and nerve power exhausted by such training as is frequently undergone for competitive examinations. We know of repeated instances of young men breaking down under it, and in some cases permanent mischief has been done disqualifying from any future mental exertions. In others a year of enforced idleness has been the result.

The influence of examining bodies should be brought to bear on this abuse. A standard founded rather on the quality than quantity of the information demanded from the student should be formed. No young man, and, for the matter of that, no old one, could possibly acquire all the knowledge of any one science or language; but what he learns he should learn well. Acquirements which are manifestly the result rather of the memory than of the understanding should sink to a minor place in the examination. It is true that this demands much ability and tact on the part of the examiner, but the art of testing another's knowledge is in itself matter of training, and in these improved scholastic days should not be difficult of acquirement. On the other side, a fair preliminary knowledge gained at schools or colleges should be insisted on, and past work, if proved, should be reckoned as part of the necessary qualification.

We believe that these views are daily gaining ground with the public. And while it is true that the middle classes are rapidly treading on the heels of the upper in the matter of education, the upper may still hold the advantages of having a longer leisure to devote to the educational period of life.

To maintain life at its highest standard, and for the longest period, has been a problem of all time, and it has even been more earnestly considered in these days of latest civilisation.

We have enumerated some of the influences which act on the community, and have come to the conclusion that life is better tended and longer preserved in proportion as we advance in all the arts which minister to our convenience, and even to our luxury. That with this advance certain dangers have crept in is undoubted. Dangers which consist in excess are inherent in the mere abundance of the supply. That which is readily obtainable at small cost is certain to be abused by many, if only by the unwise. With the increased lights of science, and countless conveniences which minister to all our wants, material and mental, life is certainly easier with us than it was with our ancestors. But a man's " life consisteth not in the abundance of the things he possesses," said Solomon, and he might have added, what is to be gathered from all his writings, that his real, inner life is largely influenced by the use he makes of them. This is the moral secret of the world—God's abundance, and our use or misuse of it. Man multiplies many inventions, and there is none of them, not even the latest destructive engine of war, without its moral value. In that instance it is the preservation of peace.

But while we invent, and explore natural laws, we are really prolonging life. Death is being pushed off by the help of our knowledge of all that is insanitary and of the causes of diseases. Single observations, or even multiplied experiments, may seem to have no immediate bearing on our health or on our lives; but who shall say how soon the day may come when some piece of isolated knowledge shall be found to be the missing link in some chain of scientific inferences which shall establish laws of vast practical bearing on our health and life? All knowledge is the result of consecutive additions, and the most brilliant results or discoveries have been simultaneously arrived at by different observers at a distance from each other. Explorers are everywhere pushing on, and no day passes without additions to a knowledge which is surely but slowly developing the laws of nature, and adding to the sum of our life and well-being. We pass from these considerations, which are capable of great expansion, to some of the influences which affect individual life and longevity.

The practical rules of health, and the effects on it of food, exercise, dress, travelling, and such like, are considered in other parts of this work. Let us ask now how they may be best applied in a general sense.

If we consult the authorities of all time whose maxims have come down to us, we shall find that without exception they regarded man as a complex being adapted for vicissitudes rather than sameness of habits, climate, occupation, and diet. Thus Hippocrates says that uniformity of climate is not desirable. Celsus also says health is best preserved by avoiding settled habits of life, and deviating sometimes into slight aberrations from the laws of medicine, by varying the proportions of food and exercise, "interrupting the successions of rest and labour, and mingling hardships with indulgence." "He that too long observes punctualities condemns himself to voluntary imbecility, and will not long escape the miseries of disease." Sterne says, "People always taking care of their health are like misers hoarding a treasure they have never spirit enough to spend." Many will remember the epitaph on the Italian who took too much care of his health :—

"Stavo ben
Ma per
Star meglio
Sto qui."

which we translate, "I was well—would be better—here I am!" On the other hand, Samuel Johnson says, what is not to be forgotten, that "health is so necessary to the duties as well as pleasures of life that the crime of squandering it is equal to the folly;" while Addison remarks that "health itself is but a kind of temper, gotten and preserved by a mixture of contraries;" and Terence, "A principal rule of life is not to be too much addicted to any one thing."

Our capacity for variety would thus seem to be not merely the power of occasionally undergoing the greatest changes of habits and climate with impunity, but a function necessary to be exercised if we would maintain average health. Those who have followed our argument in these pages will have seen that we began by describing man as a complex machine, capable of receiving innumerable influences from without, which act on his mind and body and passions, either unitedly or separately. He is thus exposed to many agents of good and evil, but he is so constructed as to have within him the power to profit by the one or to resist the other. Thus the mechanism of his mind is supple while complex, receptive and repellent, and withal eminently gifted with selective power—knowing, like the gods, "good and evil," and able to accept or reject what is put before him.

His body is similarly constructed; and its powers of working and of resistance to destructive agents are remarkable. We are daily exposed to accident, to the contact of persons sick of contagious disorders, with our breath we momently inhale into our lungs and there put in contact with the blood itself the most noxious impurities of animal and vegetable origin; at times we have poisons in our food, which are assimilated or thrown off by the secretions. The impermeability of the human body to agents introduced from without is very remarkable. We give mineral drugs of great power, and they are either cast off at once or stored harmlessly in various parts of the body, and lie inert. Were a tenth part of the doses of medicines given daily to act as proposed, we should be more disturbed in our mechanism than is commonly the case. We mention this to illustrate the defensive activity of the system, which seems to be always employed, not only in making new tissue, but in throwing off superfluous material, either in the form of food or noxious matters, as in the case of atmospheric impurities or poisons ingested ; while provision against its own decay, as a machine, is being silently provided by the innate craving, which we all possess, for exercise of every faculty of mind or body which can alone preserve us from rust and degeneration and death.

The due exercise of all faculties is, then, the secret of the preservation of these powers. We say purposely *due* exercise, for excess means waste and squandering of forces required for other purposes. This is the reason why the advice we have quoted above is reiterated by ancient and modern writers. It was recognised that man has various powers and multiplied susceptibilities, and although many of these authors knew nothing of the structure and regulating forces of the body, they all recognised the principle that exercise is essential to the conservation of any power.

We can illustrate the meaning of this by experiment. Exercise the legs or arms, and they increase ; but when the hunting man gives up his favourite sport, his legs dwindle. Exercise the memory, and it becomes a facile instrument at command. Let it drop, and we soon come to forget the familiar book—nay, the familiar friend, and life becomes really more and more a blank. But see how the clerk at the desk, even in his advanced age, remains a perfect accountant, while he has forgotten many acquirements which once in his youthful days were a pleasure and solace of his life.

But while recommended the constant exercise of those powers which we desire to maintain in working order, we are wisely advised moderation in their use, and the tempering of one by the other. Lord Bacon says, " Entertain hopes, mirth rather than joy, variety of delights rather than surfeit of them." The moderate exercise of all organs is to be duly remembered. Cicero says, "To live long it is necessary to live slowly." And certainly all which tends to hurry and excitement in our daily occupations increases the wear and tear of the machine.

When Lord Bolingbroke was asked how he was able to despatch the multitude of affairs in which he was engaged, he replied, " his whole art consisted in doing one thing at once." Method and order in the doing of business and in the arrangement of our affairs is most desirable. Such work is best done, and such men live longest. Desultoriness, which is often coupled with high intellectual powers, is the thief of time and a waster of energy. It is the bane of many men of high imaginative powers, and is the enemy of steady work. We all know of men gifted in art or literature who waste invaluable time by flying from one occupation or subject to another, and it may well be said that

" Enterprises of great pith and moment,
With this regard their currents turn awry,
And lose the name of action."

Among the humbler gifts, but one which for health and the endurance of life is priceless—nay, without which it is said that longevity cannot be reached—is " cheerfulness." Addison says, " I scarce remember to have met many old men that had not a certain indolence in their humour, if not a more than ordinary gaiety and cheerfulness of heart ; " and adds, " Health and cheerfulness mutually beget each other."

This remark is amply borne out by experience. Aged men have of necessity undergone many of the severest trials of life—loss of relations and friends whom they have outlived, the "change and decay" of the world, possibly loss of fortune. In all that we have met, a certain equanimity in meeting affliction, which is not callousness, but rather submission, has tempered their tone of character, and thus has spared them some of the miseries of life. Such men also are genial in character, merciful and tolerant of the errors of others, and in the decline of life seem to retain more memory of the sunlight than of the storms through which they have passed.

Bolingbroke says, speaking of this period when passion has abated, and also of the abated sensibilities of age, " Let us make the passage as smooth as we can ; passions are the gales of life ; let us not complain that they do not blow a storm ! "

To those who have used life aright, and have been gifted with and cultivated the power of control, old age is a placid time, and death only a meeting with those who have " gone into another room." Life is for use and not for squandering, and, as Cicero says, " Nature has lent us life as we do a sum of money, only no certain day is fixed for payment.

TRAVELLING: ITS INFLUENCE ON HEALTH.

BY J. RUSSELL REYNOLDS, M.D., F.R.S.

Consulting Physician to University College Hospital.

Travelling in its Relation to Time—Occasional and Habitual Travelling—Travelling in its Relation to Motive—The Duration of Travelling : Time and Space—The Character and Mode of Travelling —Walking—Running—Swimming—Bicycling and Tricycling—Riding and Driving—Rowing and Sailing—Skating and Ballooning—Railway Travelling—The Accompaniments or Concomitants of Travelling.

BY the word "travelling" is intended all that is involved in "locomotion"—*i.e.*, in moving, or being moved, from one place to another. There is much movement in certain occupations, both indoors and out-of-doors; but the effects of such movement upon health do not come within the scope of this article. They are dealt with in the chapters upon the influence of exercise and other conditions. Travelling involves exposure to changes of climate, and all that such changes may necessitate, but the effects of "temperature," "climate," and the like are described elsewhere, and will be only alluded to incidentally in this place—*i.e.*, in so far as they may be the concomitants of locomotion, and not the objects for which travelling was undertaken.

The subject before me is wide and complex, and the only way in which to pass through it with any success is to arrange the matters, upon which there is much to be said, in some logical order or sequence. It is proposed, therefore, to consider (1) *travelling in its relation to time;* this includes, collaterally, some of the points involved in the consideration of *amount* and *duration*, but has for its main object the distinction in its effects between occasional and habitual travelling: (2) the *motives* and causes of locomotion—*i.e.*, whether it be voluntary or compulsory; whether it be for work or for relaxation; for amusement or for health: (3) the *duration* of journeys, whether they be long or short, continuous or broken, so as to interfere, or not to interfere, with food, sleep, and other conditions of health: (4) the *character*, nature, or kind of travelling, whether (*a*) simply personal, such as walking, running, swimming; or (*b*) assisted, by various appliances, from a bicycle to a railway carriage or a balloon: and (5) the *concomitants* of travelling, such as changes of temperature, derangements of habit, of food-taking and sleep, the exposure to noise, fatigue, and other annoyances, together with their effects on temper and moral nature.

It is obvious that in the consideration of the effects of travelling under these heads there must be much inter-digitation of subjects, but repetition will be avoided as much as possible.

I.—RELATION TO TIME.

Occasional travelling, when in moderation, is a matter of utter indifference to the majority of people who are sound in mind and body. It may give neither pleasure nor pain, fatigue nor enjoyment. It cannot be said to have any influence upon health, whatever be the form of locomotion adopted. If it be the custom of man, woman, or child to travel occasionally, by road, rail, horse, or boat, it matters nothing to them; they may neither notice the journey nor observe its absence. But if an individual be absolutely unaccustomed to certain forms of travelling, there may be peculiar effects produced on him that are painful, distressing, or even dangerous.

Many people know only too well the strain of fatigued muscles and aching of limbs that have to be borne by one who, not having been on horseback for some years, takes a brisk ride "across country" for six hours. The man who is rarely at sea may suffer much in crossing from Folkestone to Boulogne. In these ways travelling, by the very fact of its being occasional, becomes troublesome; but it is in those who, by reason of age, or infirmity, or habit, have moved but little, and that only very rarely, from their homes, that a journey becomes irksome, a thing to be dreaded, and often undergone with direct disadvantage.

Young children are often greatly upset by an unwonted journey; they are sometimes sick during the process, wakeful when it is over, or restless in their sleep. They cannot ride backwards, they feel giddy and look pale, and are disturbed for hours or days afterwards, by the noise, by the rapid passing of objects before their eyes, by the constrained postures, and by other concomitants of travel. Unhealthy and over-excitable children—*e.g.*, those of nervous temperament, disposed to choreoid movements, or to graver affections of the cerebral or spinal centres—find in an unaccustomed journey the occasion of an attack of St. Vitus' dance, or of an eclamptic or epileptic fit.

To old people, or to those who, before their time, are "aged" in their ways and constitution, an occasional journey is a bugbear in prospect, a wearisome nuisance in fact, and a cause of much subsequent discomfort, and often disturbance of health. It frequently happens that the man or woman growing old, and knowing that it is so, far better than either friends or doctors will sometimes allow, is hustled, much against the grain, to some distant place, for "change" of scene or air, or what not; is over-tired with the journey, and sometimes laid up by it, away from home; or, if not so, is during the whole period of absence groaning under the sense of that most oppressive of all wearinesses—viz., the feeling of some exertion yet to be made. There is the return journey to be gone through, and that may throw the last straw upon the already over-burdened back. This may seem a highly-coloured picture, but to those who habitually travel it is almost impossible to convey an adequate idea of the extreme repugnance and actual *malaise* produced by the thought and the fact of a journey in the minds and bodies of those in whose lives travelling is a rare exception.

If what is said here applies to those who are not out of health, but are out of the habit of travelling, it is still more obviously true with regard to those whose health is already damaged by disease, such as those who have rigid vessels, failing memories, weakened hearts, and disordered functions; those to whom an accustomed room, couch, chair, and chimney-corner have become necessities of life; and to drag whom away from home is almost as painful as to take an oyster from its shell. The attempts to make the change pleasant may be most gracefully carried out, and afford real pleasure to the kind hearts that devise them; but they may often be seen to be quite as distressing to the victim as are the condiments of vinegar and pepper to the oyster, when regarded from his point of view.

An unexpected or a long-contemplated journey, taken by one who is quite out of the way of travelling, and which journey may be exceptional in no other way than in the kind considerateness with which it has been planned and executed, has often, in my experience, induced or aggravated the very disease it was designed to avoid or alleviate; and the mind, the senses, the heart, or the limbs have given way, and the *last* journey has been taken, for it is to "that undiscovered country from whose bourne no traveller returns."

There is another general remark to be made with regard to "occasional travelling," and it is this—that, quite apart from the evils to which reference has hitherto been made, there is that which arises from excess, either in kind, duration, or continuity. "Occasionality," if the term may be allowed, not rarely leads to temporary excess; and people may depart so far from their ordinary modes of living, their habits of exercise and of rest, as to fatigue themselves perilously, and return from a "holiday trip" much more wearied than they were when undertaking it.

A gentleman once came into my company in Switzerland, who had started from England only forty hours previously, and who had undergone no "training," and was tired with many months' of continuous professional work. He ascended Mont Blanc, however, on the day after his arrival in Chamonix, and returned in the evening none the worse for his excursion. Another gentleman made a similar adventure, and was rendered *hors de combat* for some time.

Far short of such extravagances as these, which may sometimes be committed with impunity, but never without peril, there are large numbers of "occasional" travellers who attempt to crowd too much into too short a time; give themselves but scanty rest, and come home not better but rather the worse. This is true whether the travel be undertaken for rest, for health, for change, or for amusement. That which leads to this unwelcome result will be further considered under the heads of "duration" and "continuity" of travelling. We hear in these days much—perhaps a little too much—about "training;" but it is not my duty to discuss in this place the value or the reverse of that mysterious process: suffice it to say that so-called training, even if it fit a man for some extraordinary exertion, does not always fit him for anything beyond, and that a great deal of amateur training does not fit anybody for anything whatsoever. A man may be so trained as to win a race, and then untrained so rapidly that his powers of endurance and of energy are so quickly lost that the process must be soon repeated if he would race again, and thus it occasionally becomes a source of mischief.

There is another side of this question, however; for "occasional travel" may be a most beneficial process. There are many, of both sexes and of varying ages, who suffer much from the fact that they never move out of the ordinary routine of their lives. They think and feel, and "live and move and have their being," in such a stereotyped style that their physical, as well as their mental and moral, nature becomes stagnant. Any sudden shock, either of grief or of joy, disturbs them with an undue violence; and if such should not happen, the monotony of their existence renders them unhealthy and unhappy. They brood over any little thing that ruffles the even surface of their lives; make "mountains of mole-hills;" fancy that the universe is "out of joint," when it may be only that the rolls were not hot enough at breakfast; and come to regard any change in the manner or behaviour of some members of their household, or of their friends, a little more versatile than themselves, as an intended slight, negligence, or impertinence. They grow peevish and morose, or often worse; sink into a state of moral, social, and physical drivelling; and become an easy prey to diseases of many kinds. For such people nothing is more wholesome than occasional travelling—nothing more absolutely necessary. The jostle of trains and steamboats, the changes of scene, food, language, and mode of thought are the very things they need; and if such mode of treatment be adopted, many quasi-invalids are cured and fitted for the work that they have to do. Human beings were not intended to move round and round like the horses of a threshing machine, or like a squirrel in a cage—mistaking routine movement for progress; and it should be seen to, by those who regard "prevention as better than cure," that such monotony be broken, and, perhaps, sometimes rather roughly, if they would do much good. Common sense may do much to discriminate between the two classes that have been detailed, but often it is only by the knowledge and experience of a skilled physician that it may be wisely said to the one group "stay at home," and to the other, "go away." Occasional travelling is, then, either indifferent, useless, mischievous, or fatal, on the one hand; or beneficial and imperative on the other: and that which will determine the good or the bad result is a carefully-conducted examination into the state of the individual, his circumstances, and his needs, as well as an actual knowledge of the kind and amount of travelling that should or should not be undertaken. No hap-hazard application of the common, and easily-uttered advice of relatives, or friends, or counsellors—viz., "All that you want is change;" or, "you must go here or there"—can do other than harm, except upon the principle that it may "every now and then be right by chance." In minor degrees of importance the same rule holds good. It may not be necessary to uproot a family, or a part of it; but it may be, and often is, very desirable to move some part of it away; and this, if only for a short time, and as an occasional event, may be of great utility in so far as it breaks up the dull monotony of habit.

Habitual travelling is never, in my opinion, a matter of sheer indifference. If it be occasionally stopped, even for short periods, it does not come within my meaning. All that is to be said here is with regard to the effect of that which is "habitual,"—going on day after day, and year after year, with little or no period of rest, and scarcely any cessation from the regular journey to be undertaken.

It is obvious that there are many degrees of amount, continuousness, kinds, and other conditions of "habitual travelling" which have to be taken into account. Again, "habituality" varies within wide limits. There are some people who travel every day the whole year through, or with but the exception of two or three days dribbled out, occasionally, at the will of their employers. These are rare; but many men are at their work, with only the exception of one day in a month; others with one day in a fortnight; others, a very large number, with one day in the week; and these must be called "habitual" travellers.

The enormous increase of the population of London, the growing tendency to localisation of some classes of employment, and to centralisation of many trades and even professions, has led to the production of an amount of habitual travelling that was not dreamed of twenty years ago. The concentration of much enterprise and of varied classes of business in "the City," which can be carried on without residence in that famous vital organ of London, has led to the growth of our suburbs, and their population by thousands of men and of women also, who pour into and rush out of their working places daily, by morning and evening trains, omnibuses, boats, cabs, bicycles, and every practicable mode of vehiculation. The centralisation of much business at the West End, in very large houses, employing hundreds of "hands," has had the same result; and so it comes to pass that many sorts of working people, whether they be heads of firms, managing directors, clerks, or even humble artisans, are to be found rushing habitually along the same road, by divers means, hastening from rest to work, and from work to rest, many of them with but a trifling break from year to year.

The points to which allusion has just been made, as to the "causes" of habitual travelling, become important in their relation to health in divers ways. Habituality, if this term may be allowed, has its good as well as its evil effects. Let us look at what it involves :—

1. There is monotony. This is obvious when the travellers are going over the same ground, and by the same means, day by day. The routine becomes dull, stale, and—so far as health is concerned—unprofitable; and although somewhat less quickly mischievous than the monotony of idleness—by reason of the slight variation that may occur in the adjuncts of travel—the effects are the same in kind. It is the dull round of existence, meeting with the same little annoyances or pleasures, the same people, the same sequence of talk or silence, the same run of accidents, the same average of escapes; and so habitual travel comes to exert the influence of habitual stillness; and the greatest "change" that the habitual traveller can find is the change to "rest."

He longs, often, after some few years of such chronic locomotion, for an occasional rest; just as, under his other conditions, the sedentary stay-at-home may long for change; but, as the years roll on, he becomes habituated to his daily routine, and the contemplation of a few days at home, or a week from his accustomed journey, is to him as trying as is the thought of movement to one who has been without travelling of any kind for a period of equal duration. It has come to my knowledge that men are always worse in their appetite, their sleep, their temper, and their spirits when anything breaks in upon the monotony of their daily journey. They miss the exercise and habitual worry, and can not, or do not supply its place by exercise of some other kind, and then they make worries for themselves. They do not know what to do; they may have no hobbies, and may not care to buy or make them; the rest on Sunday does them no good, and they come to their work on a Monday morning feeling more jaded than they were when they left it on Saturday afternoon. The dull monotony of habitual travel has eaten into the very centres of their lives, and sapped their capacity for any pleasure outside its range. How often this occurs it is impossible to say; how much it may depend upon the manifold conditions which have led to it, would be very difficult to ascertain; but of the existence of the fact there can be no manner of doubt, in the mind of any one who has observed closely the conditions of health in those who are submitted to habitual travelling. This is true, whether the locomotion be for business or for pleasure, or as the result of some habit acquired in the pursuit of either; and this long after the one has become a necessity or the other an enjoyment. He whose "habit" it has become to move about, ceases, after a time, to long for rest—that which he once was pining for; and when it is enforced upon him, by feebleness or disease, he feels it to be the heaviest burden that he has had to bear.

This is, obviously, the result of an unwholesome process, and ought to have been prevented; but the progress of circumstances has often led to it in some such gradual way, and by such unrecognised, slow, uncomplaining tolerance, that it is only, perhaps, when too late that the reality of its mischief is perceived. Thus, " variety " may take a leaf out of the book of " sameness " and read to us the same lesson. Habituality of travelling may, in one, lead to unhappiness in the prospect of " rest," as marked as is that which chronic rest may induce in the mind of another to whom it is suggested to make an " occasional " journey. Both processes are unwholesome, and against either one of them all people should be on their most watchful guard.

Allusion has now been made only to the daily, or almost daily, travelling of those whose business or conditions of life lead to its occurrence. But there are very many others, although a far less numerous class, to whom a limited amount of travelling has become a habit, and who, from the " force of habit," suffer, if by any means the routine of their life be interfered with. All of us know some friends, and many more acquaintances, whose habit it has been to " go to the seaside," to some " mountain air," to this or the other " water-drinking place " in Germany or elsewhere, and to whom the interference with this particular habit, of travelling hither or thither, once or twice in the year, would be as grave an event as the change of the Ministry, the annihilation of the law of gravitation, or the discovery of perpetual motion. They would think that they ought to be ill, and they assuredly would feel so, although there may have been not the slightest occasion for their travelling; and years afterwards, when the vexation, disappointment, and unrest, at having been baulked of their habitual journey have done their work, they will tell the last physician whom they may consult that all their ailments were due to their not having gone to Buxton or to Homburg three or more years ago.

In such ways " habitual travelling " may become mischievous, and this in a twofold manner—*i.e.*, on the one hand by doing harm, when it is long continued, without any break; and on the other, by leading to conditions of health, both of body and mind, which may become actively morbid when there is any interference with its routine. Journeys have been taken because it has been the established custom to go through them; and if anything breaks in upon that custom, there is worry, vexation, and imaginary ill-health, and sometimes the imagination becomes father to the fact.

2. Another manner in which habitual travelling tells upon health is in "loss of time." The hours that are spent by the majority of travellers, to and from business, must be taken from either business, rest, recreation, or education. It cannot be well supposed, certainly not believed, that an hour, more or less, spent in an underground railway, omnibus, tramcar, or other mode of conveyance, twice daily, can be of any direct use. That it may be a means to an end is not disputed; for some advantage may be gained by mere change, and by some fresh air and out-of-door occupation, at the beginnings and endings of days, during six months of the year. It may be good for a family to live out of town, and it may be of use to the worker to be quiet in his place of sleep. But, admitting all this, there is so much time to be taken out of the day of twenty-four hours; and if this be reckoned at two hours a day, it is clear that half a day—twelve hours—is spent per week in locomotion. Few men can work well for twelve hours in a day, so then practically it is the loss of one whole day in six, or in seven days, supposing that the Sunday is a day of rest or change. This is a serious item in regard of health, and even if a man reads in a train, omnibus, or tramcar, he certainly does not improve his eyes or his brain, although he may acquire knowledge. In short it can hardly be doubted that the time occupied in such a way is generally a loss, and a loss that must tell in some way or another upon health. It may be that *rest* is curtailed, or that home affairs do not receive their due attention; and so comes *worry*. It may be that some work is left undone, or done imperfectly; and then comes *vexation*, and nights are passed in broken sleep. Again, meals may be hurried through, food taken in imperfect quantity, and often of worse than imperfect sort; and so follows *indigestion*. Wives and children are often neglected—the latter sometimes scarcely seen; and so *domestic troubles* may arise. Taking all things into consideration, then, in connection with daily travelling, it is impossible to lay down a general rule as to whether the balance is on the side of good or evil: this can only be decided in individual cases.

3. There is a condition of fidgetty anxiety, unrest, or "strain" that, in the vast majority of people, is inseparable from habitual travelling. In some it may be a minimum of inconvenience, and may be scarcely felt. Arrangements for the journey are planned beforehand; there is little in the nature of the occupation followed to disturb the routine of life. The distance and conditions of travelling may be such as, in themselves, are the best of the kind, and months and years may pass on without annoyance of cognisable sort. But, even under such circumstances, and allowing that the traveller is a man of cool temperament, and not easily disturbed by the little strain of daily journeys, under ordinary conditions, we must remember that the routine of life is liable to accidental interruptions. There comes disturbed health at home; wife, or child, or servant may be seriously ill; or the traveller may be himself unwell; and then the inexorable journey becomes a great inroad upon time that is required at home; and fret and worry to "catch the train" are added to the anxiety that the accident has caused. There is brought in thus the element of "strain"; the loss of time and the loss of rest—such as is contingent upon loss of time and the addition of strain over and above that which the illness may, *per se*, have caused; appetite fails, too often excess of

stimulants is taken, and in this way health is undermined or broken down, and it is impossible to affix the limits to the mischief that has been done.

But there is much more than this to be considered with regard to the strain of constant travelling. There are those whose temperament is not equable, whose homes are not always centres of domestic ease and quietness, whose journeys are not at all well arranged, involving several changes of vehicles, and a succession of exposures to all sorts and conditions of discomfort in "weather," and all the absence of due protection against its changes. These things become a daily worry, a source of vexation and annoyance, the effects of which have not passed off when the return journey has to be made, and the sense of strain goes on with a *crescendo*, from the desk in the city to the doorstep of the home, and comes to an inharmonious *coda* when the door is opened. The stifled or diverted irritability is let loose, and the last state of that man, at night, is worse than the first, when he started in the morning. If he be afflicted thus, it is quite certain that his home suffers with him, and that travelling, if not an unmixed evil, is by no means an uninterrupted good.

Add, in imagination, to this picture the forces of colour, light, and shade that would be brought to bear upon it by the introduction of any domestic calamity, such as may ruffle severely the most quiet and well-ordered home; and then it is difficult to see what the ending may be, although we may know what its progress often has been, for it combines in itself all the conditions of personal ill-health, of body and of mind, and all the increments of domestic chaos. Now, what is urged here is, that very much of this depends upon the fret and fidget of habitual travel, and the loss of time which such travelling involves. The amount of evil may be small or great, but its cause is there, and is an essential and unavoidable element in constant journeying.

4. The effects upon health of "habitual" travelling are influenced, as on those of "occasional" travelling, by the duration, character, and length of the journeys undertaken. It is not intended to point out here the nature of such effects in detail, but simply to say that, other things being equal, the evils that are due to "monotony," to "loss of time," and to "strain," are in direct ratio to the amount of journeying that is undergone. Whatever is bad in travelling to a small extent, both night and morning, is made worse by protraction of the journey; and the only apparent partial exception to the general principle just enunciated is with regard to "monotony." Be it remembered, however, that, although a varied mode of progression from one place to another that shall occupy one hour, and cover a distance of but eight or twelve miles, may be less injurious than a journey of like duration which should convey the individual through thirty miles, yet, so far as "monotony" is in itself to be considered as a cause of disturbed health, it is as great in the one instance as in the other; and the increase in the duration of monotonous travel augments its influence for evil in direct proportion to that increase. There can be no doubt then of the truth of the general proposition, that habitual travelling, in so far as it is injurious, is so in direct ratio to the time and space by which its amount may be measured.

II.—Relation to Motive.

Almost everything that can be written about travelling must impinge upon *many* points; but those *two* to which attention is especially directed in this section are the voluntary and involuntary (compulsory) motives, or occasions of travelling. It is obvious that much must be involved in "motive;" much that has come, and will come, under consideration in these pages is dependent upon conditions which motive must determine. The proximate causes of good or evil may be in the "occasionality" or "habituality" of travelling; but they may be greatly augmented or decreased by that which determines the occasion of travelling to begin with. Journeys, habitual or occasional, may be taken for one's own pleasure, or at one's own discretion; they may be long or short, hurried or slow, convenient or inconvenient; and they have their effects, advantageous or disadvantageous, as the case may be. Other journeys are undertaken under pressure of circumstances; they are more or less determined by powers outside the control of the individual who has to undertake them. He often thinks and speaks of himself as the slave of circumstances; the servant of a master whose will he cannot resist; whose authority he cannot question; whose commands he dare not disobey. It matters not whether this tyrant be a master or a mistress, a profession or a party, a vestry or a clique, a firm or a family; it matters not to consider in and to what degree every man is bound by laws made for him, and laws which he has made for himself; it matters not whether or no there really be any laws or forces which control or determine movement; whether or no a man has the power of choice as well as the sense of its existence; whether or no he can or can not do anything against his own highest pleasure, or against the powers and conditions that surround him: for, whatever view any individual may assume, or, indeed, verily believe himself to have adopted on these questions, the fact remains that the almost infinitely vast majority of mankind—educated or uneducated, civilised or savage, philosophic or empirical—do practically, and that daily and hourly, act upon and believe in the principle that, with regard to some matters, they can choose and act, and that in respect of others they cannot. Whether it be so or not is a matter of no importance for my present purpose; for it cannot be denied, by any one who looks at life as a fact, that some people travel because they choose to do so, and others because they cannot help it; and the effects of such travelling upon health may be good or bad, in varying proportions, in relation to the "voluntary" or "compulsory" nature of the circumstances that determine its occurrence.

Voluntary.—Travelling which is determined by a man's own choice, and governed by his individual discretion, may have, in its own way, all the good or bad influences already mentioned under the first section. It may, again, have effects upon health that will be discussed under other sections, such as "duration" and "character" of locomotion. But what is to be said here is simply in relation to that which is at the will or fancy of the traveller; it is the effect produced by journeys that are consciously under individual control.

A man may, in order to gratify some whim, some fancy, some notion, some fashion, some vanity, some desire for distinction, or what not, resolve to travel. He may make his own plans; start when he likes; return when he likes; go here or there; choose this mode of conveyance, or that; in fact, determine the whole career: and what is now asked is this—Does such travelling incur any risk as to health, and, if so, in what way? In my judgment there is risk, and in the ways that will be mentioned.

1. The very fact of the voluntariness of the journeying has its dangers. There is the temptation to do out-of-the-way things, and to do too much; to go to places that are unsuitable, because they are so; in other words, to do something "striking;" not to associate with the less fortunate people, who are seeking health, or doing work; but to gratify a pleasing sense of vainglory in being quite independent, and somewhat *outré;* and figuring on a very small platform, and gaining some dim suspicion of applause, for daring, or endurance, or intrepidity in "tempting the unknown." Many people in this manner—or, rather, guided by this notion—injure themselves. They expose themselves to undue fatigue, or rush into conditions to which they are not only unaccustomed, but for which they are not prepared; and, when deranged in health, with which they have ruthlessly tampered, or suffering from ills that they might easily have avoided, find themselves laid aside for a time, long or short, by the results of the exposure that they have themselves brought about. When there is nothing to guide the travelling of one who wanders at his "own sweet will"—*i.e.*, nothing wiser or better than his own caprice—it often happens that the journey, if not accompanied by accidents, is fraught with fatigue and unwholesome incidents that bring with them their own reward.

2. The mere fact of voluntariness, the absence of motive for this or that, leads often to a misery of purposelessness that in itself keeps people awake at night, puzzling themselves as to what they should do to-morrow, and bringing them home dissatisfied, and often worse.

Involuntary.—But it is in the *compulsory* travelling that the worst effects are witnessed. The very sense of taking journeys that are imperative has in itself an element of fatigue and disquiet. To follow the mandate of another, or to be compelled by circumstances to go here or there, often induces a condition of mind the reverse of healthy, and aggravates the petty annoyances and fatigue of travelling until they become grave offences against the laws of health. A journey undertaken for no purpose whatever, *malgré* all its inconveniences, may be not only without any detriment, but positively enjoyable; while the same piece of travelling, if it be enforced, becomes an actual nuisance, a source of annoyance and unrest, and of more or less protracted disturbances of health. Such journeys are generally undertaken "against the grain," and every one knows how "sharply set" the nerves are under such conditions, and how much more susceptible the traveller is to all the ill-effects of the manifold discomforts and depressing conditions of locomotion.

The mere fact of compulsory travelling may be in itself thus injurious; but if the journey be of such sort that by either its habitual recurrence, its kind, duration, or exposure to other inconveniences, it is, *per se*, mischievous, then all the effects of these conditions are exasperated when it is compulsory.

Habitual and compulsory journeys are injurious in the manner that has already been described; but compulsory and occasional travelling involve often very much more. There often lies behind them much that, in itself, is the occasion of great disquiet. They occur as the result of grave anxieties, and the traveller is frequently carrying with him a burden that he can or could bear only with great strain when surrounded by the comforts of home; and he, alone, plodding onwards, with this gradually increasing burden of suspense or sorrow, has often broken down, and been unable, at the journey's end, to transact the business that he had to do, or "break the news" that he had to bear. Most distressing examples of this feature of travelling have come under my notice again and again; but they cannot sometimes be either avoided or helped; and so life goes on, and cannot, in its hurry, stop to make way for either mourning coaches or broken hearts.

Compulsory journeys may, on the other hand, be followed by good effects, when they are enforced in order to break in upon self-ordained idleness or routine, and when no other proceeding can avail. Sometimes a man may be made to travel, against his will, but to his great advantage, when the proposition of any other kind of change would be resented, or turned aside.

III.—Duration.

Both "time" and "space" come under consideration here; for a journey may be "long" or "short" in relation to either one or both of these conditions. A journey may be long, and last for many hours, days, or months, on the one hand; or it may be comparatively short, so far as time is concerned, and yet, on the other hand, be very long with regard to the space that has been passed through. Or, again, it may include both elements, and be, in the same instance, both long-continued and far-reaching. The effects differ, and we consider, first—

Time.—This not in the sense of "habitual" or "occasional" travelling, but of the duration, or of time occupied, and that continuously, by a journey, or repeated journeys.

1. There are, in many instances, distinct advantages to be gained by a "long voyage," or a long travel, whether by sea or land. A short break into a habit of thought, of business routine, or of the general mode of life, may be of no service. A few weeks may involve all the worry of a change, with but little of its advantage; and the return at the end of that period may be marked only by disappointment and vexation; while a prolonged absence may or might have been the means of restoration to health. There are many people who never "take a holiday" long enough to do them any good. By the time that the first sense of weariness is passing away, and the trouble of the preparation for the journey, and its actual occurrence, are beginning to be forgotten, preparations for going back again have to be made, and but little good is gained. Many professional men, as well as others, know this by sad experience; and the often-repeated expression of disappointed travellers and their friends or relations is, "the time was too short; he was more tired when he came home than he was when he went away." A journey should be long enough to give rest as well as change; and the advantages it can

secure increase with the extension of time in "geometric" rather than "arithmetical progression." The tired man may gain some good, for example, by a holiday of three weeks; but he gains much more than twice that amount of good if his recreation period extend over six weeks, and if he knows beforehand that it will do so. It has often occurred to me, as it must have done to many other physicians, to say, "You need six or twelve months rest and travel," and to be met by the question, "Will not three or six months do?" and to find afterwards that the smaller allowances that patients had given to themselves were not enough, and that the larger had to be made afterwards, and this at a considerable sacrifice. It is, of course, impossible to regulate beforehand the time that should be occupied with anything like mathematical accuracy; but some calculation may, in the majority of instances, be made, and the physician does not often err on the side of recommending too much, if the value of his advice is to be measured by its effects on health. If a long period of travel is held to be not only highly desirable, but necessary, this should be spoken out at once, so that the necessary arrangements may be made, and thus the further discussion and disappointment, that follow tentative travelling for a shorter time may be avoided. There can be no doubt as to the efficacy of a "long sea voyage" in many cases, and the good results to be so obtained are often in direct proportion to its length. Fragmentary "yachting about," here and there, may be pleasant and useful in certain instances, but the good so gained bears no constant proportion to that which may be derived from a consecutive journey "round the world," or a sail to Australia and back.

The mode in which protracted duration of travel is beneficial is in the acquirement of a habit of rest, and in its continuance for so long a period that it wipes out the remains of fatigue, and the anxiety and suspense of settling what is to be done; and is not disturbed by the constantly recurring question, "When will this be over?" What is to be said upon the advantages or the reverse of long journeys, in so far as they are determined by the "kinds" and "conditions" of travel, will be found in the following section.

2. If travel well-devised and long-continued is good in some cases, it is equally bad in others, where it is ill-arranged, unnecessary, and often entered upon for no good or adequate reason, and yet long-continued. Every one knows how strongly tempted some people are, when they once start from home, to forget that they are not steam-engines, guided by a skilled "driver," and fed by a "tender," and that they require both guidance and supplies. They set off on expeditions quite foreign to their habits, neglect the most obvious conditions of health, and continue an amount of daily and nightly fatigue that they would, at once, condemn if it were inflicted on a horse or dog. There would seem to be a sort of passion or infatuation possessing some people when they commence a journey. They think that they can do anything and brave everything that may come before them. Tired, it may be, to begin with, they go on and on, and at last break down from irregular feeding, loss of sleep, actual muscular fatigue, and nervous strain. The journey that they have undertaken might have done no harm if it had been broken up, so that a few more days might have been occupied in its accomplishment; but the prolonged and continuous strain has been too much, and the length of the journey has been the

element upon which the mischief has depended. It is not only in persons of extravagant notions about travelling that such discomforts may be found, but in a much larger class who may not be excessive in the abuse of time, but who are continuously doing just too much. They do not like to give in or delay their movements, and so they go on and on, without sufficient rest, and more or less quickly lose their zest in travel, and feel it to be an unadmitted bore; but their plans have been laid, and day after day the sense of weariness grows, and that of enjoyment dies out, and they succumb, it may be to the effect of only some trifling ailment, which fortunately puts the brake or drag upon their movements. They have tried to crowd too much into the time allotted, and in this sense their travelling has been too continuous and too long.

Space.—Under this heading are included the different effects of travelling, in so far as they are dependent upon the number of miles that may be passed through. A journey of three thousand miles may be tedious and monotonous; or it may be attended by constant change, and so lose its tedium. It may, on the other hand, be confined within the limits of scores or hundreds of miles, and yet be useful or the reverse, in relation to the mode of travelling, and to the time that is occupied.

1. The advantages or disadvantages of *journeys of long range* depend upon the character of the individual, his state of bodily and mental health, his circumstances, and the objects that have determined the journey.

(*a*) A journey over a wide tract of country, involving much that is new in habit, food, and scene, may be of great value to one whose monotonous and either overstrained or idle life has induced querulousness, apathy, hypochondriac notions, or incipient melancholy. For him there may be nothing more directly useful than continued change. The current of common, every-day thought, feeling, or occupation has to be diverted; and this can rarely be obtained except by traversing many places, and meeting in each with some new object of interest—something which "takes him out of himself" and away from his habitual conditions. This necessarily carries with it the element of time; but it is not mere duration of travel that is needed; it is that which space alone can confer. The advantages to be derived, in such cases, are in proportion to the distance travelled, and the variety that such distance offers. It is quite possible that this may be overdone, but that is a fault of arrangement and of detail, not one affecting the principle involved.

Again, it may be very desirable to obtain long absence from an unhealthy climate, or set of conditions; and that which obviously presents the greatest advantages is "a long sea voyage." Such may not be possible without passing over many hundreds or thousands of miles of sea. There may be nothing to be gained by the diversion which travelling across country can afford. Rest, monotony, the absence of worry, and the presence of some mild amount of variety, day by day, may be all that is needed; and this may be obtained by the voyage. There is nothing to be considered, nothing to be planned; no question to be settled every night, and acted upon every day. The whole of the proceeding is mapped out beforehand; there are no letters, no newspapers, nor any fear of them. What is wanted is rest and refreshment, regular hours, and well-arranged and varied meals. If these be secured, then great good may be done, and a wide range of sea-travel may be the most efficient means to obtain these ends.

(*b*) There is another side to this question. Journeys of long range have sometimes been undertaken when not required, when not advised, and often when quite undesirable. In such matters, sometimes, a man consults himself only, or follows the advice of a friend; or is simply induced, by the mere absence of motive to do anything else, to set out on a long and varied journey. His brain is teased, his muscles strained and wearied, his temper ruffled, his rest broken, and the unceasing and protracted changes, without purpose or enjoyment, become a wearying trouble, and at last he returns to his home bothered in mind, and often seriously disturbed in physical health. He has gone over too much ground in too short a time; and, having exposed himself to very much variety in modes of living, has often but himself to blame for his misadventure, which condition of mind, if not altogether unpleasing to his family, brings but little consolation to himself.

If set out upon, in this somewhat "accidental" manner, such journeyings may be of worse than no service; and it is obvious that when they are undertaken, as they often are, by those for whom they are the worst course imaginable, the results may be most disastrous. There can be but few families, there can scarcely be any physician, who has not met with instances of the evil here alluded to. Repeated change inflicted, when rest was needed; the protraction of variety in the sources of discomfort, when all the comforts of home were wanted; fatigue increased, when there was no strength to be spared; and the absence of good care, when wise thoughtfulness was an essential of relief, have combined, under such conditions, to do their very worst, and often to induce most grave degrees of illness.

There is another manner in which a wide range of travelling may be, and often is, injurious, and that is when the variations of climatic and other influences have not been fully taken into the account; and this applies to travelling by sea as well as by land. To these effects allusion will be made in the next section, when long sea voyages will be more especially considered.

There is one more topic to which reference must be made here, and that but briefly, for it will be dealt with in Sections IV. and V.—passing through much space in a short period of time, and that habitually, or even casually. My own experience of the troubles of others leads me to this conviction—that a journey, say from Brighton to London, or a journey of fifty miles, taken daily, or twice daily, as the case may be, and occupying an hour and a half, is more injurious than is a journey of the same duration, but which covers only half the distance; and that the first cause of such injury is in the rate at which that space is traversed, and the determining cause is in the character of the travelling, for it must be by "railway."

IV.—The Character and Mode of Travelling.

In this section is included all that has to be said with regard to the good or bad effects of locomotion, in so far as these are determined by the kind of journey undertaken, or the mode of passing from one spot to another. It will be well to classify the varieties in the modes of travelling under the following heads :—

A.—Personal, or unassisted: walking, running, swimming.
B.—Mixed—personal, but assisted: horse-riding, bicycling, tricycling, driving, rowing, sailing, skating, ballooning.
C.—Impersonal, or dependent: carriage-riding, railway travelling, some forms of sailing, or steaming.

In category A the whole motive power is that exercised by the individual himself. It is the sole and efficient cause of his own locomotion. In class C he may exert no force of his own; he is simply conveyed by other forces than his volition or his muscles. In group B he makes a varying amount of effort; but is either (1) assisted by means that reduce the quantity of force employed by saving some sets of muscles; or (2) he is helped by an additional force supplied from without. The bicycle and the boat are examples of the first; riding on a horse, or driving in a carriage, are examples of the second; while railway travelling is an illustration of the third.

A.—PERSONAL OR UNAIDED TRAVELLING.

1. *Walking.*—There are differences to be observed between the effects of habitual, occasional, voluntary, and compulsory walking, whatever may be the amount of ground passed over or of time that is occupied. Many men walk for simple, pleasurable exercise; others walk to business; others take "walking tours." In these there may be excess, and its effects.

Nothing may be more useful than a daily walk, proportioned to the capacity of the individual, and taken under healthy conditions; but there is much walking now being done that is out of all proportion to strength. A few examples will suffice to show the kind of evil that may be produced. One professional man walks to and from his place of business, and often with advantage; but, for another, the walk may be too long, and sometimes hurried; and at the close of some hours in court, or office, or elsewhere, when his mind and heart may have been on the strain, he thinks to "walk off" his fatigue; but instead of doing so he adds another element of nervous waste, and is too much tired to eat or sleep. Doctors, professors, lawyers, clergymen, and business men often injure themselves in this way. Daily governesses, and teachers of many kinds, do the same. Sometimes this is done because it is thought to be good for health; sometimes it is the habit in order to save expense; but whatever be the motive it is often injurious to health, and a perversion of so-called economy. Grievous instances of this mistake have frequently come within my observation; and the advice to set a limit to such undue exercise has been followed by most beneficial results. It is impossible to lay down any hard and fast rule upon this matter; but this may be said, in general terms, that the exercise which becomes tedious, and which diminishes appetite and the capacity for sleep, is too much, and should be curtailed. A certain degree of "fatigue" may be quite wholesome, but beyond a definite degree—*i.e.*, when accompanied as has been said above—it is distinctly mischievous.

Observe here that some people may never walk, or walk only to such degree as to be next to nil, and yet they may be well and full of work. Others may walk habitually and to a great extent without any injury. There is, however, a very frequent miscarriage of common sense in this matter, and it is this: a man on five days of the week takes no exercise whatever, but on the sixth (half-day) walks ten or twelve miles, and on the seventh day twenty, or five-and-twenty. This he may continue doing for months or years, under the impression that his Saturday and Sunday walks are good for him, and that they are a "set-off" against the absence of physical exertion on the other days. It has often come to my knowledge that this has done much harm, and against such extreme variation in this habitude of life my protest is most strong. It would seem that some people start with an idea that so much walking ought to be done per day, and if it cannot be done on five out of the seven in a week, it is to be made up for by an excess on the other two. Others seem to be possessed with the idea that, say, four miles daily must be walked over, in order to secure freedom from gout, headache, indigestion, or any other ailment; and so, accepting unconsciously the theory that man is an automaton—to be governed by rules instead of being the master of his own activity and the maker of his own rules—they carry pedometers, and if the regulated number of miles has not been traversed, set off on a monotonous pilgrimage, when tired at the end of a day of work, in order to work up to the regulation amount. This sometimes may do no harm, but it often deprives a man of what he more sorely stands in need of—viz., rest.

Something must here be said about "walking tours." These are admirable when well arranged, but very ridiculous when out of all proportion to the habits of life and actual physical condition of the persons undertaking them. There are very many who know full well that a walking tour, planned to do so much in four or six weeks, has been pleasant enough to them during the first eight or ten days; has then become wearisome to the flesh and vexatious to the spirit, and has yet been continued because they did not like to "give in;" and at the end of the allotted time—if they have not collapsed before—would tell their doctor as well as themselves that they had done too much, and were—to use a common expression —"done up." Instead of going back to their ordinary avocations, they have to "take rest," in order to get over the effects of their attempt to be made stronger and better by much walking. There has been in the therapeutics of the past, and there is in the present, something which may account for this. Even under doctors' orders, people were "pulled down" by one mode of treatment, and then built up by another. They were starved, and bled, and walked, until they could neither stand nor sit, and then were fed up and stimulated to a degree supposed to be commensurate with the reduction; and they were sometimes "cured," but more often "killed." Bleeding is not much in fashion now; but still people are sent to one watering-place to be starved and purged, and then to another to be "made up;" and many know with what bad results. This idea of knocking down and building up often passes nowadays out of the doctors' hands; and many think that they know what is best for themselves, and so they set off on a tour of walking to take down so many pounds of weight, and, having succeeded in accomplishing their purpose, find themselves much less able to bear the weight that they have left to carry.

2. *Running.*—There is a great physical difference between walking and running. In walking the body is always supported by one leg on the ground; in running

it is, between each step, unsupported for a short and varying time. In walking, however fast, there is continuous support; in running, however slow, there is a break. A man may walk four and a half miles in an hour, and not be "out of breath;" but he cannot run three and a half miles without being so. It may be little or nothing to the healthy runner, but it is a fact that, even with less ground traversed, he breathes more frequently than the walker. This is so because, during that interval of suspension in the air, and as a means for its preparation, the chest-walls have to be "fixed" by the voluntary determination to run, and the quite involuntary arrangement of the muscles which have to carry out this act. The muscular fatigue of the limb muscles in running may be the same as that incurred in walking over a given space in an allotted time. But the conditions of the muscles of respiration are different in the two forms of locomotion. The walker may quicken his pulse and respiration, but he does so in quite a moderate degree; while the runner increases them to a degree that, in proportion to the rate of movement, is marked and may be mischievous. This depends upon the fixation of the breathing apparatus, in order to lift both feet off the ground at once. This fixation is at its maximum when either foot is raised, and at its minimum when each is again put down. There is a fraction of a second when breathing ceases. This is at the moment of elevation, and the fraction is very small; but if a man breathes when at rest from fourteen to sixteen times in a minute, and when walking briskly at from eighteen to twenty times, he will, in running, make from twenty-five to thirty inspirations in the same time; or, in quick running, his number of respirations will be carried far beyond these figures. Now, it is not the increase in the actual number of respirations per minute that is of so much importance as the special conditions which determine this increase, and the fact is that there is a short period of time that is passed at each step without any breathing movement whatever. The results of such fixation are found in lungs, blood, heart, and brain. The chest-walls being fixed, and at the point of nearly full expansion, the lungs are doing no respiratory work for that time, and are kept at undue strain, and so the air vesicles are unduly distended. The arrest of respiratory change induces diminished oxygenation of the blood, and so the lips become dusky in tint. The return of blood from the lungs into the heart is free, but its exit is opposed, and so the heart becomes dilated; while the return of blood from below and from above—that is, from the body generally and from the head—is opposed, and so there arises fulness of the vessels in the brain, showing itself externally in suffused and projecting eyeballs and dusky lips; and internally by giddiness, or confusion of ideas, and sometimes by the rupture of a vessel.

I have often seen boys and young men running a "paper-chase," or playing at football, who had blue lips, were breathing forty times in a minute, and with eyes "starting out of their heads;" and I have afterwards found dilated and weakened hearts, with over-frequency of beat, and irregularity and intermission, as the direct results of such frequent strain. If such things be recognised early, and while there is yet time for development and growth, and provided also that the young but suffering athlete will do what he is told, such mischief as may have been caused may be reduced to a minimum, or may pass away. But under opposite conditions—*i.e.*, where growth is completed, and the temperament is such that the exercise is maintained in spite of warning—there has been permanent disablement, from the rupture of a vessel in the lung, from unalterable disease in the heart, or from deranged circulation in the brain.

It does not come within the scope of this paper to describe what may arise, of either good or evil, when "running" is undertaken in games of various sorts, such as cricket, football, racing, and the like. The evils which may result from violent exercise are fully discussed in another section of this work. Allusion has been made here to the effects of running generally as compared with walking, and I have only illustrated those points by reference to games.

3. There are but a few lines to be written with regard to "swimming" as a mode of "travelling." It is not until quite lately that there have been any examples of its use for that purpose; and it is not part of my duty to discuss such events as swimming across the Channel.

B.—MIXED, OR ASSISTED, PERSONAL EXERCISE IN TRAVELLING.

(*a*) The bicycle and the tricycle, in their present popularity, are affairs of quite recent date. The old velocipede was in times past an oddity, amusement, or hobby of the very few; but the bicycle has now become an "institution," and many hundreds of men, of varying ages, are travelling daily with such assistance as it renders. Apart from all that may be said with regard to the bicycle as an amusement, it is a matter of fact that a large number of people use that machine daily for the purpose of work, and that they pass over a larger number of miles in a shorter period of time than they would do if unassisted.

The locomotive power is supplied by the muscles employed; the bicycle has to be conveyed as well as the rider. Wherein, then, consists the gain? How can a man carry himself and his bicycle with less fatigue than he can carry himself? The answer is obvious—that, by maintaining the posture of "sitting" the legs are relieved from all the muscular exertion that is required to maintain the "upright posture." We neither stand nor walk without employing much energy to maintain the erect posture; and much of the energy so consumed in standing, or walking, or running, is saved by the bicyclist.

To "accidents" that may occur this is not the place to refer. They are obviously much less common with the tricycle than the bicycle, but the amount of energy employed in the former is greater than in the latter, and the gain, *quâ* locomotion, relatively less. The effort to "maintain balance" is less with the former, but the weight to be moved is greater; and the mechanical arrangement for the conveyance of motor force is opposed by a greater amount of friction by the necessary conditions of the machine. However, admitting this, there is a gain in both speed and distance traversed as compared with walking, and so such appliances must be held in respect, and treated as distinct advantages to the travellers by their means.

Have they any disadvantages of another kind? None have presented themselves to me, and all that have come to my knowledge have been the results of accident.

Sir Henry Thompson has informed me that he knows of no further evil than that of accident; and that inquiry among others, which he has been kind enough to make for me, has not yielded any other result.*

(*b*) *Riding on Horseback.*—This is one of the most enjoyable and (in point of health) profitable modes of locomotion. The really motive power is supplied by the horse, and all that the rider has to do in travelling by such aid is to guide that motion to the destined end.

Here, as in the preceding paragraphs, nothing is to be said about "accidents:" but this must be noted—that there are great varieties of horses, and also of riders; and that the conditions of good and evil vary between the extremes of good riders on good horses on the one side, and bad riders on bad horses on the other; and between these two extremes every variety of comfort or discomfort may be found. For a fearful, timid, or anxious rider—a man who is not "at home on his horse"—nothing can be much more worrying and depressing than to ride. The fatigue comes from uneasiness of mind, insecurity of body, and such riders do themselves much more harm than good. Such men, feeling worried and troubled, often throw the blame upon their horses, whereas the real fault is not in the horses but in themselves. A good rider is not to be easily made; and all the attempts to make some men riders only end in disappointment and disgust. Horse-riding, as a means of travelling, should be limited to those to whom riding is a pleasure. Many men ride daily to their business, and may have done so in the hope of gaining good; but they often present, as the result of such riding, all the miseries that have been described in preceding sections as accruing from unwonted travelling, whether that be excessive in time or distance; and over and above this, all the troubles that are contingent upon overexertion of any kind.

Allusion must be made here to travelling on horseback by those whose physical condition renders such mode of locomotion mischievous in some other way than by fear or fatigue. There are some who suffer from hæmorrhoids, prolapsus ani, hernia, or that peculiar pain (rheumatic or gouty) that is felt in the last joint that is movable between the sacrum and its coccygeal termination, and of these there are many who have their troubles exaggerated by horse-riding. Horse exercise should be avoided by those who suffer from diarrhœa, menorrhagia, or leucorrhæa, when either one of them is profuse; but it may be of great service in the opposite conditions of constipation, and amenorrhœa; and when these two have coincided, as they often do, for a long time, in spite of the careful administration of well-selected drugs, all that has been aimed at has sometimes been secured by well-regulated horse-exercise. To say this much is not, it is to be hoped, "travelling" too far beyond my boundary.

(*c*) *Driving*—*i.e.*, driving your own horses for the purpose of travelling—may be a most enjoyable pastime, or a most troublesome occupation. In the one case, pleasure, exercise, and rest, depend upon the conditions of weather and of roads, in so far as they may play with or against you in the journey undertaken, when time is of no consequence and locality is of less, and all but "the weather" is under your own control. In the other case, the journey is one not of pleasure, and can very rarely be so in a country such as this. Many of the old "travellers" are to be found still, going across country in their gigs, and with the samples of their goods; but, where railways have intersected the land, the old-fashioned traveller is amusing rather than useful, and shares the fate of those who have reproduced the "old stage coaches" for their greater gratification in killing time than in employing it.

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* Sir H. Thompson says: "Having seen no evidence of mischief caused by it, except by way of accident, I have made inquiries of others. The result is, that I have been unable to hear that any one attributes to the ordinary use of the bicycle the production of any disease, although among professed racers mischief is supposed to have arisen from overexertion, just as may happen in any other athletic exercise."

No objection is here urged against the "driving" of either gig or coach in so far as these are admitted pastimes, or individual peculiarities; but they are practically defunct as means of ordinary locomotion, and require no further notice here than this—viz., that they conduce to health or the reverse in proportion to their consonance with those general rules that have already been laid down.

In speaking of driving, we must not forget drivers of cabs, omnibuses, drags, vans, market carts, postal carts, barges, hearses, and the like. Each one of these occupations has its peculiar risks—its special influences upon health. In the one group the evil effects may be due to the time occupied, the continuity and monotony of the drive; in another to the character of the hours, and the variety of exposure to weather, and power of bearing it; and in a third to the moral effects of the occupations, and its exposure to all the interferences with health that such occupations entail. There are many differences of effect to be observed among those who travel by night and those by day; between the somewhat merry occupation of a stage-coach driver, and that of the man who drives a hearse, in his miserable garb, in his at first assumed, and at last natural, look of melancholy and physical depression; and there is a wide divergence between the smart Hansom cab-driver, who comes out when he likes, and the unlucky hirer and driver of a four-wheeled "growler," whose hours have no beginning and no end, and who, if rarely looked up to, is still less rarely overpaid.

(*d*) *Rowing*, in so far as it is mischievous in its effects upon health, is so in the same manner as is running. It necessitates a fixture of the chest-walls, and consequent acceleration of the respiration and the pulse. So long as the number of strokes per minute is not in excess of the number of respirations per minute in a healthy man, when either walking or standing, rowing does no harm. The seaside sailor who pulls his heavy craft at the rate of fifteen or twenty strokes receives no harm, although his work may be hard and long-continued. But the half-stripped racer, in his lightest boat, injures himself if he will increase his breathing to double or treble its physiological rate, and this he must do if he increases his number of strokes per minute in that ratio. The more eager the race, the more rapid is the stroke; and in so far as breathing is concerned, it is in proportion to the rapidity or the frequency of the stroke that such forced rowing becomes injurious. The time that is occupied, or rather the duration of forced breathing that is thus induced, has much influence upon the effect. It is one thing to put on a spurt of five minutes' duration, and quite another to maintain an exaggerated rate of breathing for half an hour. I have frequently seen oarsmen dusky in face, blue in lips, and with projecting eyeballs, just as the race is over; and with pallid face and ashy lips, after a few minutes' rest and breathing-time have enabled them to pull again.

(*e.*) *Sailing* requires only this to be said here—viz., that when a man sails his own boat, and takes upon himself duties for which he is not in physically good training, he runs a risk of encountering more bodily fatigue and more mental strain than that which he is able to bear; and so often fails in personal health, while perhaps he is conferring great enjoyment upon others.

(*f.*) *Skating and Ballooning* have hardly yet taken their place in modes of travelling, and the most that can be said about them is that they involve a certain amount of risk to life and limb which is small in the one case and relatively great in the other.

C.—CARRIAGE RIDING, WITH NO EXERTION.

In carriage riding, railway travelling, and some forms of sailing or steaming on the sea, there is complete immunity from actual, personal exertion. Such locomotion needs no exercise of will, or muscle, and yet it may be productive of much mischief or much good.

1. *Riding in carriages* drawn by horses has its fatigue and worry. No one who has travelled in an old stage-coach, or in a diligence, is unaware of what is meant. In both conveyances he is cramped and crowded with necessary or unnecessary packages; he is shaken over rugged roads, or stifled with dust; and so at the end of a day's journey is sometimes worried out of his temper, if not out of his senses, and is unfit for the next day's work.

But, apart from these inconveniences to which our fathers were subjected, there are those that are involved in what is known as a "tour on the Continent," where carriages are used now as they were in years gone by, but with this disadvantage, that since the railways have made their appearance, the diligence, the carriage, or the coach are not as well appointed as they used to be. So far as I have seen, in much travelling, both in this country and elsewhere, there has often been the attempt to do too much in a short space of time. Hence comes early rising, carried to an unhealthy excess; long hours of travelling in uneasy carriages; and much disappointment at not reaching the appointed end at the time that was fixed upon; irregular feeding, and broken rest, and all the evils that such conditions carry with them in their train. These unpleasant things occur in the finest weather, but they are aggravated a thousand-fold in bad weather, and by the thousand and one accidents that always occur in travel. So it happens that those who journey by diligence or car or coach often suffer more than they would have done in years gone by, or than they need have suffered now, if they had been content to avail themselves of railways and tunnels and other advantages that have been introduced during the last half century. Carriage driving has its pleasures and advantages, but many of these exist in imagination rather than in fact. It may be very plausible to say and to think that your time is at your own disposal; that you go where you like and stop where you like, and so arrange things quite in accordance with your own schemes and wishes. But the vast majority of people find that a Scotch driver, or Italian voiturier, is as tyrannical in his orders as is the railway official and the railway train, and that they are at his mercy in their journey;

that they are obliged to get up when he orders, and stop when, where, and as long as he pleases; and so find themselves to be but slaves of their own servants for the time being, instead of being the accommodated and tenderly-handled occupant of a carriage under railway control.

But, it may be said, some places we wish to visit cannot be reached by railway, and we can make our own plans if we choose to do so. There is travelling which must be done here and there by driving, if it has to be done at all; but, let it be asked, is much of this travelling, in any sense, necessary? It may be; and then the best plan is to make the best of it; but a vast amount of journeying of such sort is by no means necessary. It is undertaken to gratify a whim or fancy; and it has not fallen to my lot to see any people so much vexed by delays as those who chose this mode of conveyance of their own sweet will. Again, it may be very well to say, before starting, that all things are in your own hands; but, as a matter of fact, it is not found that you possess this absolute control. Horses may fail, and harness may break; the wheel may come off, or the drag-chain be broken; and when these things happen, any one or more of them, you are at the mercy of the driver, and he may detain you to any warrantable or unwarrantable extent.

In these ways travelling by road may be a great wearisomeness to the flesh, and a greater worry to the spirit; but if all goes well, the journey may have been fraught with much pleasure. But it is often very wearisome, even then, and the discomforts produce many ills of fatigue and ill-temper that are injurious to health.

2. *Railway Travelling.*—In what has been already said, in previous sections, this mode of locomotion has been alluded to; and all that has been uttered with regard to "time," "amount," "motive," "conditions," and the like, apply also to railway journeys; and so the only points to be considered here are those which especially belong to railway travelling.

Railways, and railway carriages, differ *inter se*; the road may, on the one hand, be good, and the carriages well made; or, on the other hand, the lines may be uneven, the carriages badly poised, not firmly coupled, and their interior arrangement, as to both height and breadth, quite inconsistent with comfort. With these, at least six, elements to be taken into notice, the permutations and combinations are, indeed, very considerable. There are, at least, some seven hundred possible conditions to be taken into account! These may be for good or evil, and must be variously mixed; but let us inquire as to the net outcome of railway journeying, and try to see in what way it differs from any other.

The ratio of time occupied to space traversed is unlike that of any other mode of common locomotion; for the number of miles passed through in a given time is greater than that accomplished by any other mode of ordinary travelling. The rapidity of transit is greater, and this has its effects of a somewhat subtle character. Let me take (1) as an illustration, a journey of twenty miles, in a non-stopping train. The man takes his seat, and the movement begins, and it may be gradually, and, at the end of twenty miles, the train pulls up, and the journey is over. It may have occupied thirty to fifty minutes; but the speed has been, with varying amount, such as to expose eyes, ears, muscles, and nerves to a constant succession of sights, sounds, postures, and efforts, so that, be the carriage ever so well appointed, these conditions have had their physical effects. There is pulling at the eyeballs on looking out of window; a jarring noise, the compound of continuous noise of wheels, and this conducted into the framework of the compartment; with the obligato of whistle and of the brake dashing in occasionally, and always carrying some element of annoyance, surprise, or shock; there is the swaying of the train from side to side, or the jolting over uneven rails and ill-adjusted points; and the general effect of these upon the temper, the muscles, and the moral nature. Let all that is especially, or accidentally, out of order be left out of consideration, and suppose that all is as good as it can be, and yet there are the residua that have been mentioned. There are "impressions" that are made, and that unavoidably, by the very conditions of the journey; and they involve fatigue. The eyes are strained, the ears are dinned, the muscles are jostled hither and thither, and the nerves are worried by the attempt to maintain order, and so comes weariness, that may be dissipated in a few minutes by a walk, and may mean nothing when such journey is occasional. But if it be habitual, then much may creep on, quite insidiously, that it may be quite difficult to get rid of. If, in order to "rest the eyes," a man takes to reading, he does not deliver himself from the other sources of discomfort; and as regards the eyes it is not certain which may be the worse of the two—to see objects passing rapidly, or to have the strain of fixation of the eyeballs on the lines of a newspaper or book. The man, for the time being, becomes a part of the machine in which he has placed himself, being jarred by the self-same movement, and receiving impressions upon nerves of skin and muscle which are none the less real because they are unconsciously inflicted. In this there is not rest, but exertion and fatigue.

Compare with this (2) a journey in a "stopping train," with all the modern appliances of starting quickly and pulling up abruptly, and there is an amount of muscular annoyance and moral vexation that is proportionate to the number of stoppages. The suddenness of movement or its arrest is most trying to very many. Their backs are jarred; their reading is stopped; first thrown forward by a sharp application of the brake, and then backwards by the fresh start of the engine, they have no sooner settled themselves into their seats than the same processes are repeated, and these *usque ad nauseam;* while each jar and jolt has its accustomed shriek of whistle and grind of brake. It has been my misfortune sometimes to pass over eight or ten miles in one of these trains, in order to save time; but I do not hesitate to say that the fatigue at the end of such a journey has been greater than it would have been if I had walked the distance, and ten times greater than it would have been had any other machine been adopted, save perhaps a market-cart without springs jolting over an ill-made road. But "time is money," according to an old copy-book maxim; and so, in this way, thousands of people daily "save" those two elements included in the proverb, as they think; but often find that they have made a false calculation, and that they have "lost" *both* in the illness that compels them to take a long period of rest. It is no marvel to me that so many are thus injured. The only thing that astonishes me is that so many go on for such long periods of time unscathed. A "railway accident" may kill or injure many in a moment; and then there are columns of newspapers full of accounts of the accident; and trials take place for "compensation;" but these events bring into notice only a few cases, while the chronic collisions in a hundred trains, night and morning, are doing the same kind of work, and inflicting damage to valuable lives. But this is done so gradually that it is only after a time that the ill effects are recognised. What I have said may possibly be distasteful to many who may read these pages; but I am convinced, from large experience, that the evils are not overstated. That which enables me to say this with confidence is something like the "proof of a sum"—viz. this: that often when I have counselled a change in the mode of travelling, and such change has been adopted, all the troubles of health have passed away. This has been so when the advice was not too late, and when it has been followed, by those whose symptoms were never, in their own minds, connected with their travelling, but were in such a way dependent upon it, that the change of form in locomotion has led to their removal. Briefly stated here, the symptoms have not been fatigue of muscles or any conscious strain; but those of incapacity to attend to business, want of quickness in perception, or an irritable over-sensitiveness about little things; uncertainty of judgment, hesitation about trifles, exaggeration of feeling, with failure of memory; an inaptitude for work quite beyond description in words, but yet a recognised fact; restlessness by night, weariness by day, with loss of appetite and loss of weight; or sometimes a stolid indifference to this or that which demands attention, and a most trying sense of worry about business, or about health, that makes life quite miserable and often useless.

3. There is much railway travelling that does not fall into either of the groups of journeys just described; they are supposed to be short, but other journeys may be very long. Instead of from ten to forty miles being traversed daily, the cases to which reference is now made are those in which the distance passed over is much greater, and may be, taking the average of years, one, two, or even three hundred miles per day. Some men may continue such an amount of travelling for years before they fail in health. They use the "express trains," and perform their journeys under the most favourable conditions of carriage; but they suffer as they do so, and often are loth to believe that their sufferings have anything to do with their mode of life. Many who take that "very easy journey" from Brighton to London and back again, daily, say that it is no fatigue to them. They find their newspaper at the one end, and read it until they reach the other, do their day's work, and repeat the process. This travelling may not harm some people, but others it may. These last gradually become unwell, and consult a physician as to the set of symptoms described above. They take this and that in the form of medicine prescribed with a view to combat the special difficulty or discomfort they may feel, but they get no better; and at length some change in habit may occur by accident, or may be recommended upon quite another ground; the daily journeys are done away with for a time, and they are well. But the old miseries come back when the old habit is resumed, and it is not until the travelling is stopped that the discomforts cease. How many have

found this out for themselves it is impossible to say; how many go on with impunity I cannot tell; but of this I am certain, that a large number of those who have suffered have been obliged to alter their plans, reduce their travelling, and have got well; while others have gone on in spite of warning, and have been compelled to give in at last.

There is much travelling that far exceeds the journey of one hundred miles daily. There are many whose avocations call upon them to pass over far wider tracts of country. They have the habitual, monotonous going backwards and forwards from this place to that; but they take numbers of long journeys of many hundreds of miles per week, going from north to south and from east to west, and traversing thousands of miles per month, in order to conduct their business. They "break down," and in the ways already described; and there are two principal directions in which their troubles come—viz., in failure of brain or heart. Memory and judgment become impaired, with loss of power to concentrate thought and pay attention to the work in hand. Or, there is breathlessness, with discomfort about the heart; some fulness of the lower limbs, with the sense of great weight and weariness; inaptitude for exercise, and incapacity for sleep; and the man often says, "I am undone, and yet I am not ill; I cannot do what I used to do, nor can I bear what I used to bear." He may go on to say, "I have taken rest"—and this may mean that he has gone to India and back for a three-months' tour, or has rushed about the Continent of Europe, from Calais to Trieste, from Moscow to Madrid; and, "as travelling never hurts me," he may say, "I am surprised and disappointed that I am no better; I have come home expecting to return to my work, but am quite unfit to take it up. What am I to do?" How often this kind of story has been told to me I need not say, but my answer to the question has been imperative, and in one word, "Rest." After such advice has been followed, the result has been entirely satisfactory; but very much more often the kind of question that is asked is this: "Can you not give me something to take besides rest, so that I may go on?" The answer should be, so far as my experience teaches me, an emphatic "No; there is no second best; you must reduce your travelling for a time to *nil*, and never again attempt what you have done before." This advice followed, many have found some way of so arranging and diminishing their journeys as to do great and valuable work, and, still further, to enjoy their lives.

If it be asked, "what is there in railway travelling that is so bad?" my reply is contained in much that has been already said, but with this further addition, which will be best made by two illustrations. Every one must have seen a restless, crying child taken on a nurse's lap, laid down, and patted on its back, at the rate of ten pats in five seconds, sometimes fifteen, sometimes twenty; so that the number of "pattings" ranges from six to twelve hundred in a minute. The vehemence of such pattings it is difficult to measure, but it is generally in proportion to the noise that the child may make. The poor little creature, after the administration of some eight or twelve hundred knocks, becomes quiet, and is said to be "asleep." Gentle swaying in the arms, hither and thither, has done no good, but this "patting" has been wonderful in its effects. Now, allow that the prone posture and the dorsal knocking may have put some intestinal flatus in a less uncomfortable position than that which it occupied before, it is quite certain, in my judgment, that such a readjustment cannot account for more than a small fraction of the therapeutical result. The child has gone through a series of "concussions" of its brain and spinal cord, and has been "concussed" to "stupor." It is not healthy "sleep," it is unhealthy "coma," that has been so induced.

My second illustration may be verified any day and by any one who will take the pains to observe what he may see in an afternoon train leaving the city, or any other terminus. Eight gentlemen take their seats in a first-class carriage; one with a basket of fish, another with fruit, others with newspapers, or what not, they are brisk and lively in talk, and are not over-fatigued, worried, or out of health; but not long after the train has started one drops his book, another his newspaper, a third is bored by the man opposite who will talk, and so puts his head into a corner, and, as I have often observed, within twenty minutes—nay, even within ten—more than half the occupants of the carriage have been asleep. This may be seen, although not to the same degree, in a morning or mid-day train; and my belief is that the same thing occurs here as in the case of "patted" baby—*i.e.*, that the condition is not wholesome "sleep," but a kind of "stupor," induced by "concussion of the brain." It may be said that these are strong terms; but I know not any others that would adequately convey my meaning. The state induced is not "sleep," but a "stupidity," or "stupor." The jar of the train shakes, knocks, or "concusses" the head, and brings on the stupor. It may soon pass away; it need not occur; but it can be seen so frequently, and it takes place with such rapidity, that it is quite impossible to account for it by all, or anything, that we know with regard to sleep. Such concussion is not confined to railway carriages; it may be seen in omnibus, tramcar, or any other mode of conveyance; but it is in the train that it is observed the most frequently and the most distinctly; and it cannot but be mischievous, as much so as any dram or drug that would or could produce a like effect.

V.—The Accompaniments or Concomitants of Travelling.

It may, I think, be taken for granted that, as a general rule, "regularity" of habit is conducive to health, and that "irregularity" is, more or less, injurious. It is of importance that meals should be taken at the same hours, day by day; that they should be of wholesome sort; that the hours of rest, and sleep, and awaking, should be orderly; that dressing, undressing, and washing should be also not rudely interfered with. But travelling—except such as is habitual and planned—breaks in upon all these conditions. There is scarcely one that can be maintained "on a journey." A hurried breakfast takes the place of an ordinary meal; sandwiches are provided, or bought at a place that may be the only one accessible, and these are taken instead of the ordinary lunch, and often at an unaccustomed hour; there is no proper sleep; and the accessories of health are nowhere. What has to be said here may be considered under the following heads:—

(A) Changes of temperature and climate are the natural concomitants of travelling. There may be much, or little, or none; but often when there is "much," the traveller is sorely tried. Any one who journeys from Paris to Marseilles, for example, or *vice versâ,* knows that he may pass from winter to summer, or the reverse, within a few hours; but sometimes he may be unaware of the provisions that he should make. Hundreds of people, every season, go, in a few hours, from the scorching heat of Interlachen to the cold of Mürren, or from Lucerne to the Rigi Culm, and are quite unprepared for the sudden change, which may afford pleasure to the strong, but is attended with great disadvantage to the weak. To leave Marseilles at the close of a summer's day, to go to sleep in the train, and to wake in a damp, miserable, foggy morning at Fontainebleau, and cross the Channel to Dover in a snowstorm, may be an accident, and sometimes a serious one; but it is what hundreds of people undergo in the months of January, February, and March, of every year, and they often suffer seriously in consequence. All the good that has been gained by two or three months' sojourn in the sunny south has been undone by a journey of twelve or twenty hours, and "bad colds" are "caught;" and there is, in addition to the annoyance that they may cause, all the vexation, and disappointment, and fatigue that many know too well. Add to this all the misery that accompanies such journeys to those who cannot afford to ride in sleeping-cars, and have everything that they need prepared beforehand, and it is not hard to answer the question, "Did this travelling do any good?"

(B) Changes in habit as regards "food" are, perhaps, worse than those which depend on temperature, for the latter may be of but short duration, whereas the former may last for weeks or months. "You may find something to *eat* beyond this," an experienced upper waiter and traveller once said to me at Geneva, "but you cannot *dine.*" There is a truth in this; for, although the boundary line is being moved farther away in all directions, there is yet a limit marked without much length of travelling in almost every country. In a small village that boasts three "hotels," within six miles of a favoured and fashionable "watering place" on the south coast, I found, not very long ago, nothing to be had for lunch at either of them save a piece of stale, hard cheese, some musty bread, and some sour beer. It is not long since that the only change in diet that could be obtained in the Lake district was, as a distinguished authoress said, "from eggs and bacon, to bacon and eggs;" and this elaborate *mênu* is all that may be encountered in many of the south-western counties. This may be all that a hungry walking tourist cares for, and it may not do him much harm; but it is not the diet that is desirable for one with tired brain and disordered stomach, who is obliged to leave his home in order to find rest and change of scene. On the other side of the Channel, even in out-of-the-way places in France and Belgium, something really wholesome and palatable may be usually obtained, but in the south of France, even in large and much-frequented towns, many have again and again complained to me that they "could not get enough to eat." The cup of tea or coffee in the morning, the *déjeûner* at noon, the *table d'hôte* at six, were neither one of them sufficient in amount, nor in accordance with their usual meals; and so they felt hungry and tired when they went to bed, unless they supplemented their meals with some odd things in the middle of the morning, the last thing at night, and on awaking the next day.

In Germany, and in much of German-speaking Switzerland, the heavy mid-day meal is a terrible burden to the Englishman; the evening meal, taken at either nine or half-past nine o'clock, is, according to circumstances, too heavy or too light, and always too late, for if there be an evening *table d'hôte* it is generally arranged to take place just at the time when the traveller wishes to see the sunset, or some other natural phenomenon which he has travelled a thousand miles to see, and his only chance of doing so is to go without his dinner.

These conditions of annoyance affect those who, while "travelling," are staying here or there, and are in possession of some control of their movements, and having some, but yet limited, power of arranging their hours of feeding. But the vexatious and cruel manner in which travellers are treated in this country and elsewhere while "on the move" is beyond all powers of description. Occasionally a journey may be taken in which no annoyance may be felt, but such journey is a rare exception; while it is common enough to have to go without food for twelve consecutive hours, by either night or day, or to find only such as it is impossible to take, from hurry, and noise, and railway unpunctuality, or from its quality being such that the digestion of an ostrich might be disturbed by its outrageous tax upon all peptic power.

Allow that the arrangements are sometimes such that no serious complaint can be made against them in one particular journey, it will almost invariably be found that this is by sheer accident, and that this one lucky piece of travelling is, so far as feeding is concerned, but part of a general plan, as stereotyped as the railway guide, as bad as its printing, as narrow and as hard as the rails on which the train is passing.

These discomforts may be nothing to the young and healthy, but they are most wearisome and mischievous to those who are neither young nor strong, and who have almost forgotten what the feeling of health was. That which makes so much of this maladministration provoking is a knowledge of the ease with which it might all be altered, so that journeys would be deprived of four-fifths of their fatigue. It does not seem to have entered the minds of those who arrange our journeys for us that some people do not begin at the beginning and end at the terminus, but that it may sometimes happen that the ticket is sometimes taken an hour and a half after the train makes its first start, and that the victim stops an hour and a half before the terminus is reached. He has his entrance and his exit at some place where nothing can be obtained to eat or drink, and between his two points there may not have been sufficient stopping time allowed to get even a bun or a glass of water. This occurs in England often enough, but on some lines abroad, and especially in Germany, it is quite frequent. The only creature that is considered is the engine; and the time that is allowed for it to slake its thirst is not long enough for any human being to eat and drink.

(c) The arrangements for some necessary processes of life are in a few instances good, in others bad, and in others *nil*. There are in some compartments of carriages, and in the Pullman cars, and in sleeping carriages, conveniences that rob a journey of much of its trouble. There are, too, on some of the ordinary trains in this country and abroad, travelling closets; but in all trains, except those which are met with in Russia, Switzerland, and America, they are practically almost useless, because there is no mode of communication with the conductor, and no possibility of passing from one carriage to another.

The outside arrangements are in themselves fairly well attended to in this country on some lines; but they are not enough to meet the difficulties of many who, from weakness of limb, or inclemency of weather, and hurry and bustle at the stopping stations, are utterly unable to make use of them. On the continent of Europe they are, in a few places, exceptionally good; but, as a rule, they are simply disgusting, and a disgrace to the age in which we live, and, unfortunately, have to move. In this way travelling is often rendered not only a pain and nuisance, but a source of actual, and often long-continued, disease.

(D) The moral disadvantages of travel are often very great, and some have become so habitual, and thus so aggravated, that they form no unimportant element for consideration.

For instance, there is the noise, the bustle, and hurry of trains, their frequent unpunctuality and waste of time, the fussiness of their officials, who, after delaying the passengers for some unaccountable stupidity of their own, jostle the travellers suddenly into their carriages, with shouts of "Take your places; going on!" or, "Prenez vos places! à voiture, à voiture!" as if the train had been kept waiting by the victims of their faulty administration; and all these things are trying to the "temper," and lead to strong expressions of disapprobation, which it would not be well to repeat.

Again, there is, in this country, but more habitually on the continent of Europe, the chronic annoyance of smoke by the engines, and excessive smoking by the passengers in places other than those specially set apart for their convenience. It does not matter at what hour of the day or night the journey be undertaken, or whether it be by train, steamboat, or any other public conveyance, "where'er one's footsteps wander," there is, "greeting one everywhere," tobacco, and often none of the best. One of our own homely poets has said,

"'Tis wrong to bring into a mixed resort
What makes some sick and others *à la Mort.*"

But that this is one of the concomitants of travelling, thousands of both men and women know only too well. I am sure that this is unconsciously done by hundreds; it may be that their own personal enjoyment of the "fragrant weed" is projected, by their minds, into an imaginary conferring of delight on others, and that only a little consideration of the matter might enable them to enjoy their cigar without making their fellow-travellers unwell.

In other ways, too, does travelling often tend to make people *selfish.* Every one rushes to get the best place that he can, and to secure personal comfort at the expense of others. It is almost impossible to take a single journey without seeing this. It may be in the opening or shutting of a window, in the selection of seats, in the exposure to sun or shade, in securing the best points of view, and so on. This is not peculiar to travelling. Many when they have heard the last song of their favourite soloist move out of the concert-room, and rush for their carriages, treading on the toes of those who may come in their way, and buzzing past them with flounces and fans, with opera hats and lunettes, while those who really care for music fail in trying to hear the last grand chorus of Handel or Mozart—the close of a great work—which was not intended by the master composers to be an obligato to the tramp of feet or the shuffling of dress. But these people are "travelling" somewhere, and although it may be only through a concert-room to a carriage, they are possessed for the moment by the consideration of self.

Lastly, travelling conduces to much dishonesty, sometimes encouraged by words, often by silence, and still more frequently by what is called elsewhere "bribery and corruption." Does one not often see all the *four* corners of a carriage "taken" by *two* people, and all the intermediate seats covered with rugs and handbags? Does one not often hear it said or acted, "that all the seats are taken;" and this when only two out of eight were paid for? Francs or half-crowns are given to officials, who are prohibited from taking gratuities on "pain of instant dismissal," while of late days the discovery of such mode of obtaining a seat in "another place" would have set a constituency free to make another choice. The same spirit is seen in the mode of obtaining rooms in hotels, and in the mode of their allotment by the hotel keepers; and in a hundred ways travelling conduces, not only to bad temper, annoyance, and selfishness, but also to untruth.

Thus, travelling may be harmful in the very many ways that have been described; but, on the other hand, it may be, and often is, one of the greatest helps that man can have in his journey through this world, and through this life; it may help him to do the work that is given him to do far better than it could have been done without its aid; it may help him to bear his sufferings or his sorrows by making him stronger to endure; it may afford him time and rest, to regain his strength; it may expand his mind, and enlarge his heart, and render him a more useful member of the family, the society, and the country to which he belongs; and it may teach him lessons of self-control, self-sacrifice, and fair dealing, that he can ill afford to lose, but could gain by no other means. We are all "travelling," by longer or shorter stages, and with varying speed, to one common rest—'the undiscovered country, from whose bourne no traveller returns;" and let us see to it that we are all friends, and each and all helping one another on our way.

HEALTH AT HOME.

By SHIRLEY F. MURPHY.

Medical Officer of Health to St. Pancras.

Relation of Health to Home Conditions—Situation of the House—Soil—Construction and Arrangement of the House—Prevention of Dampness—Walls, Chimneys, Roofs, and Floors—Rooms and Furniture—Water Supply—Storage of Water—Filtration of Water—Disposal of Refuse—Faulty Drains and Disease—Drain Ventilation—Cesspools—Dry Methods of Disposal—House-dust—Ventilation and Warming—Lighting—Artificial Light—Necessity for Cleanliness—Sickness in the Home.

RELATION OF HEALTH TO HOME CONDITIONS.

If we look back upon the history of past times we cannot fail to be impressed with the fact that, with a comparative disregard for those conditions which we believe now to be essential to health, our country was able to produce a race of strong, hardy men, who did great deeds, overcame great obstacles, and lived to a considerable age. With this fact before us, it may be asked, what need is there for us to consider how and in what manner we shall live? Is there any real reason for the growth of a demand, which is becoming more and more pressing, that the every-day conditions of life shall be regulated by considerations for health?

The answer is not far to seek. In the times to which we refer, there were many who lived to grow up and carry out the duties of life—many, for the world was then large as it is now, and there was no lack of people to inhabit it. But for the many who lived, how many died? How many were carried off in babyhood, in childhood, and in the prime of youth, when life was just beginning to open before them?

Nothing is more appalling than a study of the rate at which people died a few centuries ago. A bare reference to Hecker's "Epidemics of the Middle Ages" tells how hundreds of thousands were smitten by disease which visited the country at that time. In the year 1348 the plague alone carried off half the population of England (Green), and "the ravages were fiercest in the greater towns where filthy and undrained streets afforded a constant haunt to leprosy and fever." In 1666, in six months, one hundred thousand Londoners died of the plague which broke out in the crowded city. But those who died from epidemic disease were few compared with those who were cut off by diseases which were constantly operative. No very trustworthy statistics can be obtained on which to calculate the death-rate of the seventeenth century, but so far as it can be ascertained it probably amounted to fifty annually for every 1,000 of population living, and other evidence tends to show that during that century the number of deaths exceeded the number of births. Our forefathers, then, did not escape from terrible visitations of disease, but suffered in a degree to which there is no parallel in our times.

But it must not be assumed that in the old times no knowledge of the requirements of health was possessed by our countrymen. Law after law gives evidence that the rulers of the time were to some extent alive to the necessity of guarding the public health. Fitz Elwynne's Assize of Buildings, issued in the reign of Stephen, had regard, it is true, rather to the prevention of fire than to the prevention of disease; but the regulations which he made concerning "necessary chambers" prove that he knew the importance of dealing with, at any rate, this point; while the subsequent efforts made during Queen Elizabeth's reign to prevent overcrowding, and to ensure to each new-built dwelling-house four acres of land, show how thoroughly was understood three hundred years ago the necessity of a certain amount of air-space for every person. That the passing of such laws was ineffectual to prevent the high rate of mortality which prevailed is due very much to their non-observance. The laws themselves were so far ahead of the people that they were either totally disregarded, or only enforced in times of great emergency. Hence there was really but little done to prevent diseases which were almost altogether due to the manner in which the people lived.

Such is the history of the past, and such is also the history to a less degree of our own time. With all the advanced knowledge of which we boast, the rate at which people now die is a disgrace to our civilisation.

The average age which is attained by human beings living in England at the present time is less than thirty years. Of the total number who die every year, but one-tenth reach the full period of life, while somewhat less than half of the remaining nine-tenths never attain the age of five years.

How, then, do people die? At the present time the whole kingdom is mapped out into Sanitary Districts; Medical Officers of Health and Inspectors of Nuisances abound. The labour of some of our best and wisest men has been devoted for a lifetime to a study of the conditions which are really required for the purposes of health; yet, in spite of all this labour and all this thought, numbers of persons are going daily to their graves at an age when they ought rather to be looking for a better and a fuller development of the powers with which nature has endowed them, instead of dying from some diseases which either ought not to exist at all, or from others which ought to be confined to those whose advancing years make them unable to resist the changes of climate and season to which all must necessarily be to some extent exposed.

A glance at the reports of the Registrar-General tells us in what numbers people now die of diseases which we know are preventable. Thus, the zymotic class of diseases—the class which contains all the infectious diseases—destroys annually in England more than one-eighth of the total number of people who die. Diseases of the lungs, pneumonia, bronchitis, pleurisy, &c., all of which are capable of some amount of control, are responsible for one-sixth; while phthisis, which is greatly dependent on conditions which are known, and which can be altered, kills nearly one-tenth of those who die.

Where, then, is the great hindrance to the enormous saving of life which ought to result from sanitary measures? The answer which has been given for the days of Fitz Elwynne is applicable to all time since. Laws are made which are good laws, but they are not regarded by the great mass of the people. An amount of apathy still prevails which renders inert very much of the legislation of modern times. It is only as the people as a whole become educated to see the relation of certain physical conditions to their health, and learn to appreciate to its full extent the value of good health and long life, that they will insist upon every care being taken to preserve them. As yet they do not fully believe that health is absolutely affected by such conditions as the ventilation and drainage of a dwelling-house; indeed, the argument is often advanced that what was good enough for our fathers ought to be good enough for us, and it is pleaded that advantages also result from the very conditions which destroy life.

We are reminded of the old times when the Spartan mother would expose to the wind and rain her new-born babe, and would thus ensure its death were its strength insufficient to enable it to resist these cruel influences; and thus we are told the weakly were weeded out, while the strong remained to perpetuate the nation. Acting in this sense, we are asked to believe that the conditions which tend to kill the weak serve a wise purpose of nature, and help in the long run to the continuation upon earth of a stronger race than would be found if those of less robust constitution were permitted to dilute the strength of their more hardy brother by mixing their feeble blood with his.

First, we must point out that many of the diseases which we call preventable do not especially destroy the less hardy specimens. Take, for instance, the behaviour of scarlet fever among young children. Who that has seen much of this disease would assert that the weaker die, while the stronger recover? Or take phthisis—the disease from which those in early manhood and womanhood die—does this attack the invalids? Is it not rather those who are often gifted with stronger and better powers who so frequently become its victims, and, seeing that the conditions which lead to its development are becoming understood, may we not hope to preserve for the world those powers which would otherwise be lost?

But if we leave this part of the argument, and allow that some die who had better die than live to grow up to be the unhealthy parents of unhealthy offspring, we must not expect this to be the only effect on the community of those conditions which we call insanitary. For every unhealthy infant who is judiciously killed—as, for the sake of argument, we may put the matter—how many otherwise healthy persons are injudiciously made unhealthy? It must be obvious that those conditions which will kill some persons will produce in others sickness something short of killing, but perhaps more disastrous in its effects upon a larger number of people. The Spartan mother exposed her child once for all, but we pass our lives in the midst of surroundings which constantly take from us some portion of that which we know as health.

Of all the conditions which affect man, we have only to consider the effect upon him of his home. By the word home we do not necessarily confine ourselves to the bare structure of the house in which he lives, but to the use to which he puts it, and to his relation to health and disease in his association with his housemates.

To begin with, we would wish to point out that there is a very definite relation existing between the manner of construction of the house and the health of its inmates—a point upon which we wish to be particularly clear, especially as we shall have at a later page to state that there is no evidence existing worth the name to show that certain diseases have any connection whatever with house conditions which are constantly believed to cause them. This is a matter of some importance, for as much harm is done by exaggerating as by under-stating a fact; and we would wish not to go beyond what is absolutely known, or encroach more than possible upon that land of "guess" in which we so often wander.

The Situation of the House.—If we are to inhabit a house which shall as far as possible enable us to lead a healthy life, we at once ask ourselves the question, where shall this house be?

It may be stated generally that health is more readily preserved in a house situated in the country, surrounded by an unoccupied open space, than in one placed in a town surrounded by occupied houses, the smoke of whose chimneys taints the air, while the earth becomes impregnated with the filth of many a generation. In towns, to a greater extent than in the country, people are driven by habits of life and business to dwell in some more limited area, and health itself to be less a matter of consideration in the choice of locality. In country districts, on the other hand, there are sometimes also disadvantages, for the need of procuring a ready supply of water constantly leads to the erection of houses in situations which, apart from this necessity, would not have been selected.

If we compare the rates of mortality in rural and urban districts, we find a marked difference, just as we find some towns far more healthy than others—that is to say, that the people living in them die at a less rapid rate.

Health is affected by the soil on which the house stands, by its opportunity for exposure to wind and weather, and by its immediate surroundings of hill and vegetation.

The wise man who, we are told, built his house upon the rock was only considering its stability; but we, in our generation, have to think of the effect on health of the soil on which the house is erected as well as to consider how long the house will last. Perhaps we shall best understand how health and soil conditions come to have so much relation when we learn something of the composition of the latter.

Soil.—Soil consists mostly of mineral matter, to which some amount of animal and some amount of vegetable matter is added. To a varying extent it is porous, and therefore contains either air, water, or both. Now, it is upon the character and amount of the animal and vegetable matter, upon the air and water which are situated in it, that its influence upon health depends.

When soil is examined it is found to contain gases of various kinds, depending upon the composition of its solid constituents. Under all circumstances an amount of carbonic acid gas can be discovered, while in "made earth," or land which has been produced, as so much land has, by emptying into some hollow the rubbish or contents of innumerable dust bins until the ground is level, the gases produced by the decomposition of this foul material are necessarily also present. The air in the ground is by no means fixed and immovable. It is influenced by the action of the sun, by the density of the atmosphere, and necessarily by deeper currents of air which are often dependent on the movement of water. Consider, then, the effect of building on any soil without taking precautions that it shall be dry, and that it shall not consist of made earth. The house becomes occupied and becomes warmer than the outside air; the earth immediately beneath it shares in this increased temperature; air, damp and foul, rises into the house, carrying with it all the conditions necessary to produce ill-health. To show that the dampness of the soil is no slight danger, the observations of Dr. Buchanan with regard to the connection between this condition and phthisis may be referred to. During an investigation into the general effects of sanitary improvements, he ascertained that where drainage had led to drying of the subsoil, there the mortality from phthisis had decreased. The importance of this observation led to a detailed inquiry, with the result of showing that where sanitary improvements, which did not include the drying of the soil, had taken place, the death-rate from phthisis remained stationary; but where dryness had resulted, often from some accidental occurrence, there the decrease invariably took place. We may mention the towns of Salisbury, Ely, Rugby, and Banbury, where the decrease in the death-rate from phthisis amounted to from forty to nearly fifty per cent. In Alnwick, Stafford, Morpeth, and Ashby the death-rate had remained the same, although extensive sanitary improvements had taken place in these towns, which did not, however, include the drying of the soil. But the proof that phthisis is caused by dampness of soil does not rest on this inquiry alone. A subsequent investigation by Dr. Buchanan not only reaffirmed all that had been previously found, but showed in detail the geological conditions which co-existed with a high phthisis death-rate.

Dr. Bowditch,* of Boston, U.S.A., independently arrived at the same conclusions, and laid down the following law: "A residence in or near a damp soil, whether that dampness be inherent in the soil itself, or caused by percolation from adjacent ponds, rivers, or meadows, marshes, or spongy soils, is one of the principal causes of consumption in Massachusetts, probably in New England, and possibly in other portions of the globe. Consumption can be checked in its career, and possibly, nay probably, prevented in some instances by attention to this law."

These are lessons which must be recollected, for upon our readiness to be guided by them the health of the inmates of our house will to a great extent depend. But it must not be supposed that dampness of soil is a cause of phthisis alone; of the other diseases which are responsible for a large amount of mortality, bronchitis, rheumatism, and its attendant, heart disease, are much dependent on the same cause. It is even believed on good authority that dampness of soil increases the mortality of some of the acute specific diseases. Thus an inquiry by Dr. Blaxall† showed that in Swindon, measles, whooping-cough, pneumonia, and bronchitis caused twice the proportion of deaths in that part of the town which is situated on Kimmeridge Clay as in the other part which is placed 100 feet higher on the oolitic limestone and sand of Portland. There is free intercourse between both parts of the town, and no reason to account for the difference in the death-rate except the dampness of soil in the lower part, and the careless way in which the houses are built, no precautions whatever having been taken to prevent the dampness rising from the soil in the houses.

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* Mass. Med. Society, Vol. X., No. ii.

† Tenth Report of the Medical Officer of the Privy Council.

Other diseases are also related to dampness of soil. Thus, not many years ago ague was constantly found in that part of London to the south of the Thames, but it has almost altogether disappeared since the better drainage of the land.

Dr. Buchanan's, Dr. Bowditch's, and Dr. Blaxall's work teaches us that we may best escape disease by building our houses upon soil which does not contain water; that if, owing to circumstances, the house must of necessity be built upon an impervious soil, a site should, when possible, be selected on an incline, so that the water may drain away; and that if the soil be pervious, care should be taken that its situation is such as to enable it to be free from water, for it will be seen by the annexed drawing that a porous soil may easily have all its advantages of permeability neutralised by water being upheld in it by an impervious substratum beneath.

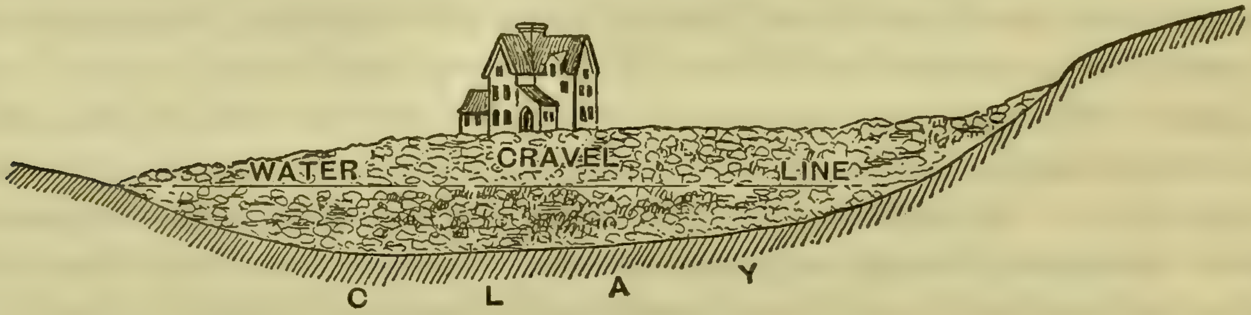

Fig. 1.

A table, prepared by Dr. Parkes, places the following geological formations in their order of healthiness for the purposes of a site :—

	Permeability of water.	Emanations into air.
1. Primitive rocks, clay state, millstone grit	Slight.	'None.
2. Gravel and loose sands with permeable subsoils	Great.	Slight.
3. Sandstones	Variable.	Slight.
4. Limestones	Moderate.	
5. Sands with impermeable subsoils	Arrested by Subsoils.	Considerable.
6. Clay, marls, alluvial soils	Slight.	Considerable.
7. Marshes, when not peaty	Slight.	Considerable.

Other considerations must also be borne in mind in selecting a site. The house should not be placed too near to vegetation, but a short distance enables woodland to afford shelter against the colder winds. In England the sun is rather to be sought after than escaped from, and hence it is desirable that the rooms which are occupied shall be placed east, west, and south.

CONSTRUCTION AND ARRANGEMENT OF THE HOME.

Prevention of Dampness.—It is evident from what we have said that in the construction of the house itself, the same dangers to health should be borne in mind as those against which we have to guard in the selection of a site. Where the soil consists in any part of made earth, the whole should be carefully excavated, and the surface covered with an impervious layer of concrete, faced with cement or asphalte, which should extend beyond the limits of the house itself, and which should be at least six inches in thickness; nothing less can be relied upon for preventing emanations from this mixture of animal and vegetable matter being drawn into the interior of the dwelling; while, even if the site do not consist of made earth, the layer of asphalte or concrete must not be omitted, as it is important to prevent even the watery exhalations from the earth from entering the building. Where the ground is damp, the subsoil of the site of the house must be properly drained by suitable earthenware pipes, and these must have no direct communication with the drain of the building for carrying off sewage, but must be dealt with in a way which will be hereafter described. The reason for the separation of these two sets of pipes is of course to prevent any emanations from the drain containing sewage escaping under the building.

Damp Course.—Immediately above the level of the ground must be introduced into the walls a damp course, consisting of glazed stoneware, asphalte, or slate laid in cement, so as to entirely separate the bricks below this point from those above, and thus prevent the passage from one to the other of moisture from the soil. Where it is necessary to place rooms below the surface of the earth, an area must be built round the wall so as entirely to keep the earth away from it. The area must be carried a sufficient depth below the floor surface to admit of a damp course being under these circumstances placed between the floor and the bottom of the area, which should be carefully drained to prevent any accumulation of water on its surface.

Walls.—The thickness of the walls must vary according to their height, but the importance of having substantial walls does not relate only to the necessity of supporting the weight above them, for the possibility of maintaining a proper temperature during all seasons is dependent upon their thickness. In tropical climates the coolness of the interior of the houses is provided for by an increased thickness of wall, which prevents the rays of the sun converting the dwellings into ovens; while in cold climates the same precaution is necessary for preventing the warmth of the rooms being lost as fast as it is produced by the fires within. Thickness of wall is also required for the purpose of keeping out the damp, but where, from some exposed position of the house, the liability to damp is considerable, the most satisfactory plan is to build double walls with an intervening space between them, the two being kept in proper position by the introduction of ties or bonds. Other methods are also resorted to for the same purpose, such as covering the outer surface with silicated cement or with tiles.

Where brickwork is used, these precautions are the more necessary on account of its porosity. Air readily passes through bricks, and, for the same reason, opportunity is afforded for water to enter them; indeed, it has been found by experiment that an ordinary brick takes up as much as sixteen ounces of water. This very power of absorbing water makes it the more important that the house shall not be inhabited until the walls are thoroughly dry.

As yet we have spoken only of the use of brick for house walls, but other materials are frequently employed, the choice of which must to some extent depend on the character of the material which naturally exists in the neighbourhood. Latterly concrete has been more freely used, and is found well to answer the purpose. Great care should be taken to ensure that whatever material is used is well fitted for its purpose, for it is not uncommon to find soft Bath stone placed in exposed situations where it soon crumbles away. Some regard must also be paid to the special atmospheric conditions to which the material will be exposed. Thus the Houses of Parliament, which are built of magnesian limestone, are, owing to the exposure to the sulphur compounds in the London air, being gradually converted into Epsom salts, a substance which, it is well known, dissolves very readily in water.

Before leaving the walls of the house, another point may be briefly mentioned. Opportunity must be given, by the introduction at proper places either of perforated bricks or iron gratings, for the ventilation of places beneath the floors.

Chimneys.—Upon the proper construction of chimneys depends the safety of the house from fire, and the freedom of the rooms from soot and smoke. The flues of chimneys should be surrounded by brickwork rendered smooth inside, and should not be allowed to run into each other.

Roofs.—The roof should be made of some incombustible and waterproof material, such as slates, tiles, or metal. Thatches are objectionable on account of their liability to catch fire and to harbour insects. The roof should be provided with gutters and rain-water pipes, into which it should drain, so that the walls and interior may be kept thoroughly dry. The method by which the water is disposed of will be subsequently considered.

Floors.—Considerable care is required in the making of floors, so as to prevent the accumulation of dirt between and beneath the boards. Various methods are resorted to for this purpose; among the best is that known as ploughing and tongueing. The woodwork should be well seasoned, so that no shrinking can subsequently occur. The lowest floor must not be permitted to be in contact with the concrete or asphalte which has been laid upon the surface of the ground, but a space of at least three inches must intervene between the two, the ventilation of which is to be provided for by the introduction of air-bricks, or by the admission of air through the damp-proof course.

The floor thus laid ought to be perfectly smooth, and capable of being washed without any water escaping beneath it, and it should without further preparation be able to be stained and waxed, or to receive on its upper surface either a thin layer of oak or of parquetry.

Arrangement of Rooms.—Very much of the convenience, the comfort, and even the health of the inmates of the house will depend upon the arrangement of the rooms and the different purposes to which they are put. Thus, to have a kitchen situated in a position where the smell of cooking pervades the whole dwelling is calculated not only to annoy, but to deprive more delicate people of an appetite for the coming meal. In English houses the kitchen is placed either in the basement or on the ground floor; whatever course is adopted, care should be taken to provide doors both to the kitchen itself and to the staircase and passage, with which it must communicate with the rest of the house. The passage and staircase should themselves have ample means of ventilation by a window opening directly into the external air. Where the kitchen can be more thoroughly separated from the rest of the dwelling-house, this should be done; but under any circumstances the free ventilation of a space intervening between the two should be effected. The kitchen itself must be provided with the most thorough ventilation, not only to carry off the smell of cooking, but to prevent its large fire unduly increasing the temperature. Where the kitchen, as in many small houses, comes to be the only sitting-room of the servants, this is especially necessary. If the floor is made of stone or concrete, it ought to be covered with cocoa-nut matting, which should be daily removed for the purpose of cleaning.

In connection with the kitchen are various offices—a pantry, scullery, and larder; all should be thoroughly ventilated, and be cut off from the kitchen by close-fitting doors. The walls of the kitchen and offices should be distempered every year, and the strictest cleanliness observed in every part. The coal cellar should also have external ventilation, and be cut off by a door from the rest of the house, for coals frequently give off moisture and gases which should be excluded from the interior of the house.

The ground floor of the house is devoted to sitting-rooms for the reason that they are more accessible from the outside when in this situation; and, again, this arrangement permits the upper part of the house to be devoted to bed-rooms—a far better position for sleeping-rooms than one nearer the ground.

The floors of neither sitting-rooms nor bed-rooms should be covered with any but movable carpets; in the sitting-rooms it is altogether unnecessary for the carpets to extend into the recesses of the room, and they should be capable of easy removal to permit of frequent cleansing. In the bed-room no carpet should be allowed to extend under the bed. The bed-room floors in the first instance may be treated as those in the sitting-rooms, and a few strips of carpet or Indian matting will serve to place round the bed, and in such other situations as may be required. The object of thus treating floor surfaces is, of course, to enable the rooms to be kept in as perfect a state of cleanliness as possible; indeed, the necessity for cleanliness has been so strongly urged by one writer, whose views are entitled to consideration, that he has not only protested against the use of curtains, but has entirely abolished them from his own house, with a result of improving the health of his family, and has, nevertheless, by a careful regard to the decoration of his rooms, produced an artistic effect of a very agreeable character. With properly-fitting windows, curtains are not necessary on the score of draught, and so far as the control of light is concerned, this is altogether dependent upon properly-arranged blinds.

Furniture in Relation to Health.—The furniture of the rooms should, of course, be arranged with the same aim; decorative opportunities for the collection of dust can, as Mr. Edis has shown, be avoided without any sacrifice of what is really needed for artistic effect. By such methods as having a flat even surface at the top of all bookcases and cabinets, instead of the hollow wells with which we are accustomed to meet, and by placing heavy furniture upon castors, so that it can be easily moved for the purposes of cleaning, opportunities for cleanliness will be given. That dust and disease are intimately associated there can be no doubt. As an extreme case we may refer to the effect produced by the inhalation of the dust given off in the pursuit of their occupation on the health of knife grinders, leading to phthisis and loss of life. It is impossible not to believe harm must also result from the inhalation of dust particles by those who are susceptible to pulmonary diseases. The appearance of the lungs of those who die enables a fairly correct opinion to be given as to the conditions under which the deceased has previously lived, there being a great difference in the colour of the lungs of those who have lived in the country and those who have passed their lives in smoky towns. Dust, then, readily penetrates the lung, and it perhaps depends upon the individual tendency to disease how much harm shall result; but it is obvious that if the amount of solid particles which thus enter the respiratory organs can be reduced, a step in favour of health is likely to be gained.

Walls may be either panelled, distempered, painted, or papered; the inclination and purse of the owner of the house must practically settle in which way his walls shall be covered; there are but three points that have to be considered by us. We have but to demand that the surface shall be kept clean, that it shall be incapable of giving off any poisonous ingredient, such as arsenic, and that the choice of colour and of pattern shall not exercise an unpleasant influence upon the minds of those who come to occupy the room.

Cleanliness, if the walls be panelled, is best insured by the avoidance of carving, and of ledges where dust might settle. The cleanliness of papers and of distemper is mostly dependent upon a sufficiently frequent renewal, but with regard to the former something may be done by avoiding those papers which are commonly known as "flock," and which readily become dirty.

Effect of Colour upon the Mind.—We would wish to dwell for a moment upon the effect of colour and pattern upon the mind. Our history tells us of a king who was treated for an attack of scarlet fever by being placed in a room the walls of which were hung with red; the light which entered it was of the same colour; while the idea was further carried out by his being made to drink red wine. The time is past for any such belief to remain in the effect of colour upon health, but there is still ample reason for thinking that colour has an influence, although of a different character from that which was thought then. In an instructive article, contributed by Dr. Wilks to the Guy's Hospital Reports,* he shows that persons of different temperaments not only are prone to special diseases, but have different habits, even to the extent of matters of dress. Indeed, the association between the dress and the disease of the individual was sufficient to cause Dr. Wilks to note that a tendency to gout was often accompanied by the wearing of a bright coloured scarf and a white waistcoat. Now we are not professing that the converse is true, and that we can cure the patient's gout by depriving him of his bright blue scarf, and surrounding him with the sombre washed-out colours which are supposed to betray an artistic feeling in the minds of those who submit to them. But, without going so far as to associate an individual colour with an individual disease, the fact remains that to a sensitive person with a tendency to despondency, the character of his surroundings is a matter of considerable importance. To put an extreme case, what would be the effect on the mind of such an individual if he were placed in a room the woodwork of which consisted of ebony, the chairs of black velvet, and the walls of so funereal a tint as to give the idea that the chamber had been prepared for the reception of the dead rather than of the living? To a man of robust mind in good health, with plenty of occupation, the general character of the room might be a matter of no importance; but for the nervous impressionable person there can be no doubt that a condition of mind would be encouraged which would not only be opposed to one of happiness, but would tend to interfere with digestion—a function peculiarly dependent on the mental condition.

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* 1868.

A number of experiments have been recently conducted in the Dundee and Kent Lunatic Asylums, with a view to showing the effect of particular colours upon the mental condition of the insane. Dr. Rorie, the medical superintendent of the former institution, noted that a violent patient placed in a room illuminated with blue light was quieted, an effect which might, however, have been due to the astonishment of the patient at finding himself in such a situation. Again, a man suffering from general paralysis of the insane, who was for convenience placed in a room illuminated with red light, was much relieved of the feeling of depression which he had before experienced, and every effort to remove him from the room brought back his depression. But it is unnecessary to go outside our own experience for the purpose of obtaining evidence upon the general question that colours affect the mind. Colours must be chosen with regard to situation. The colours of a room devoted to sleeping purposes must be of a quieter shade than those intended for use during the day. Regard must also be had to their appearance in artificial as well as natural light, and an effort should be made to obtain for the wearied eye that feeling of rest which is attendant upon the use of different colours which properly harmonise with one another.

In connection with this point, let there be recollected the intense distress and worry which is occasioned to many persons by the existence of a pattern on the wall which is capable of being counted, and which admits, by the manner in which it is multiplied over a large surface, of being shaped into a thousand forms, to the aggravation and annoyance of a person to whom rest may be of the greatest importance. Who that has passed an illness in such a room will not recollect, in the early days of convalescence, the terrible sense of duty which impelled him to count and shape into many a form the spots or squares he saw before him.

WATER SUPPLY TO THE HOME.

To say that the water supplied to a house should be pure is to make a statement which will be at once accepted by every one; but the question will be asked, what is pure water? For unless water is carefully prepared in the laboratory, it is sure to contain something more than the bare hydrogen and oxygen which, in properly combined quantities, will give us this fluid. It must be obvious that in this sense no water which is used for drinking or domestic purposes can be considered pure, but will contain other matter either in solution or in suspension.

Rain-water.—If we could procure our water supply from the clouds at a distance far removed from the impurities of the atmosphere produced by man, we should be certain of having water which would be altogether fitted for our purpose. As a matter of fact, we do obtain our water from this source, but only after it has been contaminated first by matter suspended in the atmosphere, and afterwards by such impurities as it may come in contact with after having reached the earth.

Here it may be mixed with certain organic matter, the result of both animal and vegetable life, and it may dissolve some amount of mineral matter derived from the earth itself. Providing it fall in a situation where it is retained near the surface by some impervious sub-stratum of clay, its opportunities for becoming contaminated by organic matter received from the surface are necessarily greater than if it passed to a lower depth, where, on the other hand, it is more exposed to the action of certain mineral matters. In practice, we may procure our water from rain, surface wells, artesian wells, springs, lakes, and rivers.

Wells.—Some surface wells supply water very different in character from that of others, and are often much contaminated with organic matter. The purity of the water will often depend upon the relative position of the well to neighbouring cesspools and drain pipes; instances have been known over and over again of a communication existing directly between the cesspool, receiving the excreta from a house, and the well which supplies the same house with all its drinking water.

The admixture of a certain amount of organic matter with the water under these circumstances will often charge it with gases, giving it a bright, sparkling appearance without producing an unpleasant flavour which would enable the pollution to be detected; hence, the absence of a disagreeable taste is no criterion that the water may with safety be drunk.

It is not uncommon to find a well thus contaminated obtain a celebrity due to the bright sparkle resulting from the gases given off by decomposing organic matter. Thus, the very condition which renders the water poisonous draws, like the *ignis fatuus*, to destruction those who are attracted by its beauty. But it must not be assumed that water thus polluted will at once produce disease amongst those who drink it; it may have no action at all, or may be a cause of occasional diarrhœa, perhaps not sufficient to draw attention to the water as its cause; the well, therefore, may continue to be used for a time which, by its length, convinces the drinkers that it is a pure supply, and thus a false sense of security is produced, often to be dispelled by the illness, and perhaps death, of several members of the household. For the time comes when some person contracts elsewhere what may be regarded as nothing more than an attack of ordinary diarrhœa, and calling at or staying in the house, his excreta find their way into the cesspool; from that moment the organic matter which the well receives is a deadly poison, with a power of multiplying itself until sufficient is produced to infect with a dangerous disease every member of the household. Such was the history of the pump in Broad Street, Golden Square, in 1854; there the well-water had, through the brilliancy of its appearance, obtained, not only in its own neighbourhood but elsewhere, a reputation; but an outbreak of cholera occurred in that year, causing nearly five hundred deaths in one week amongst people living in the houses immediately surrounding it; inquiry showed that those who died had drunk of the water from the well, and it was found, moreover, that the excreta of an early case of this disease must have found their way through a defective drain into the well itself. The removal of the pump-handle was immediately followed by the termination of the outbreak. As further proof that this water was responsible for the disease, may be mentioned the fact that a lady living at Hampstead had been in the habit of sending for some on account of her partiality for it, and her use of it during this period was attended by the introduction of cholera into her household.

So, again, cholera broke out in a household in Essex in 1865, and here the illness seems to have been introduced by the father and mother of a family, who were attacked with this disease while travelling. The result of their return was that eleven persons were seized with cholera, of whom all but three died; and we are told by Mr. Simon that "all drinking water of the house came from a well beneath the scullery, and into that well there was habitual soakage from the water closet."

Such calamities as these, although on a smaller scale, are constantly happening, owing to the pollution of water by sewage contamination. It must not be assumed that proximity of the cesspool or drain to a well is necessary for the contamination of the latter, for under such circumstances as a fall in the strata in which the cesspool is situated towards the well, the contents may be carried a very considerable distance.

In the same manner, a cesspool may leak into the surrounding ground, where the sewage may remain until the ground water rises after heavy rains, when it becomes polluted, and in turn contaminates any wells which it supplies with water.

We have described instances of illness and death caused by the introduction into drinking water of matter derived from persons suffering from specific diseases. It may be perhaps asked whether ordinary sewage which has not received any specific poison can itself give rise to either of these diseases. With regard to cholera, it may certainly be asserted that this specific poison is absolutely necessary. So far as the other disease—enteric fever—is concerned, we must perhaps for the present speak with more hesitation, for from time to time this disease breaks out under circumstances that are difficult of explanation, unless we assume that ordinary sewage may produce it. Nevertheless, the growth of exact medical knowledge makes it more probable that the investigation is at fault than that enteric fever can be developed from any other source than a previous case.

The risks of drinking water from surface wells may, then, be briefly summed up as consisting of those that result from drinking water polluted with organic matter, which may be of vegetable or animal origin. In this country, we have but little experience of the evil effects of drinking water containing vegetable impurities, but in other parts of the world, we are told, such water will produce malarial fevers.

Deep Wells.—The waters from deep wells are to be trusted as having a greater degree of purity from organic matter than those we have just described. They necessarily contain in solution some amount of salts derived from the strata in which they are situated. Thus, some waters are impregnated with salts of lime derived from the chalk. These waters are wholesome and very agreeable to drink, owing to the large amount of carbonic acid contained in them. Others hold in solution a larger proportion of sulphate of calcium and magnesium, and are found in the limestone and magnesian limestone strata. Both these waters present one inconvenience for domestic use; they are known as "hard" waters, and, as a result of their hardness, require a much larger amount of soap to form a lather than other waters. This fault is capable of remedy to some extent, especially in water derived from the chalk. In this water the salts of lime are held in solution by the carbonic acid dissolved in the water; by boiling it much of the carbonic acid is expelled, and the salts of necessity precipitated. The waters derived from the limestone and magnesian limestone strata can be improved by the same treatment, but to a less extent. An ingenious plan was devised by Dr. Clark for freeing these waters of their hardness: it consists simply of adding lime to the water which is already charged with an excess of carbonate of lime; by this process, the lime in the water, which is a bi-carbonate, is reduced to a mono-carbonate, an insoluble salt which is at once precipitated.

The effects upon health of drinking hard water are not very clearly understood. It has been believed that calculi result from its use, but the evidence on which this belief rests is not of a very positive character.

Springs and rivers also, as a rule, produce good water; but rain water is necessarily liable to pollution from its exposed situation. The Rivers Pollution Commission place the various waters in the following order, in respect of wholesomeness and palatability :—

Wholesome	1. Spring water.	Very palatable.
	2. Deep well water.	
	3. Upland surface water.	Moderately palatable.
Suspicious	4. Stored rain water.	
	5. Surface water from cultivated land.	Palatable.
Dangerous	6. River water, to which sewage gains access.	
	7. Shallow well water.	

Before leaving this subject, it may be well to point out that a chemical analysis of water is not to be trusted as a guarantee of the fitness of its use for drinking purposes without regard being also had to its surroundings. For practical purposes, it is of infinitely greater importance to know whether there is a possibility of the contamination of a well, either from the surface or by a neighbouring cesspool or drain pipe, than to have any evidence the chemist may produce as a result of his examination. Speaking generally, we may say that if the chemist can find evidence of the presence of too much organic matter, or too much of any of the inorganic salts which water contains, it would be a reason for rejecting the water; but we must not assume that a water which fulfils all the conditions which the chemist may believe to be required for the purposes of health must necessarily be fit for drinking. Before, therefore, deciding on a water supply for domestic purposes, we must carefully examine into all the conditions which may at any time affect it.

Let us assume we have selected our water, and that it is fit not only for the food of man, but for other domestic purposes; we have to convey it to our house, perhaps to store it, and finally to make it readily accessible. It is not within our province to describe the different means to which resort must be had to raise water from a well or spring and convey it to the house, but we will content ourselves with considering for a moment the position of a house which draws its water with many others from a reservoir, and a house which has an independent supply of its own. The same rules apply to both, and they may, therefore, be considered together.

Storage of Water.—Water should not he stored for a longer period than is necessary. Wherever a "constant service" can be procured, the householder should gladly avail himself of the opportunity. The method of storing water in houses gives rise to chances of pollution which ought never to occur. It is worth the reader's while, when he next travels by one of the many railways which pass on a level with the tops of London houses, to notice the water-butts and cisterns standing at the backs of houses old and worn, some with their covers broken, others with no covers at all, exposed to the rain, the washings of the roof and the walls of the houses, and often the receptacle of rats, mice, and even cats, which have met in them an untimely fate. If any one possessing the least thought of cleanliness and decency were to know the common condition of thousands upon thousands of cisterns and water-butts in London, he would utterly condemn a system which leads to so much evil; and yet we are not going too far in saying that, in the majority of the houses occupied by the so-called better classes, he would not find more thought given to the maintenance of the cistern in a cleanly condition than is bestowed by their poorer brethren on their more dilapidated water-butts.

If water is to be stored in a house, it is essential that the cistern shall be periodically cleaned, or no amount of care in its manner of construction will ensure a pure supply to the inmates.

The cistern should, therefore, be situated where it is accessible for cleaning purposes, and where it is not exposed to contamination from polluted air—as, for instance, in the floor of a bed-room, a not uncommon place in which to find the cistern of a modern house—and it must be constructed of a material which shall exercise no prejudicial influence upon the water. Considerable discussion has of late years taken place with regard to the action upon water of the lead of which cisterns and water-pipes are usually made, and much diversity of opinion has been expressed. Under certain circumstances, water will act upon lead, but to enable it to do so some amount of admixture of air appears to be necessary.

That lead may be used for the conveyance of water for many years there is abundant evidence to show. Monsieur Belgrand exhibited to the French Academy two pieces of lead pipe, one taken from a conduit in the Faulbourg St. Antoine, which was laid in 1670, the other being of slightly less age. After this period of more than two hundred years, the impressions of the sand of the mould in which the pipe was cast were still distinctly visible in the metal.

It will be seen, then, that no hard and fast rule can be laid down against the use of lead pipes for the conveyance of water. Even where some amount of action has taken place, a carbonate of lead is frequently formed on the interior surface of the pipe, and thus subsequent change has been prevented by the coating given to the interior; and this condition may be trusted, unless the water should be so impregnated with carbonic acid as to lead to the solution of the carbonate of lead.

In practice, therefore, we may trust to the natural tendency of many waters to preserve themselves from impurity, but for others special precautions will have to be taken. It may be well here to point out that the tendency for water to act upon lead is increased by bringing in contact with the latter other metals—such as iron and copper—which set up galvanic action, and lead to the solution of the lead. In addition to taking precautions in this respect, various plans have been suggested for producing a coating in the lead pipe, one being to fill the pipes for a while with phosphate of soda (Dr. Christison), another, with sulphide of potassium (Dr. Schwarz, of Breslau).

In some places the lead pipe has been lined with tin; but even under these circumstances the water supplied to Manchester continued to become contaminated with lead. More recently iron pipes, both cast and wrought, have been successfully used.

Much of the difficulty in obtaining definite evidence of the influence of lead upon the system is owing to the varying susceptibility of different individuals; some people have apparently suffered from so small an amount as one hundredth of a grain in a gallon, while ten times this amount is required to produce symptoms in others. We shall not, however, be acting unwisely if we recognise one twentieth of a grain of lead or more per gallon as an amount which ought not to be permitted in water used for drinking purposes.

One more word with regard to the dangers of lead, and we have done. An injury to the surface of the lead, or to the straining of it, adds greatly to the probability of subsequent contamination of the water. If lead pipes are to be used, these dangers must be borne in mind.

But whatever necessity may be pleaded for the use of lead for the conveyance of water, no such necessity exists with regard to its storage. We have already insisted that the cistern shall be made of some material which shall not exert any influence upon the water which it contains. It should be constructed of slate or galvanised iron, it should also be provided with a cover to preserve the water from impurity, and should have a discharge-pipe situated at so low a level that it can be absolutely emptied when necessary for cleaning purposes.

It is not uncommon to find in existing houses, as well as in many which are being built at the present time, that an overflow or waste-pipe from the cistern communicates directly with the drain. In this position, there is considerable opportunity, and indeed necessity, for the air contents of the drain to pass up the waste-pipe and foul the water in the cistern. Even where a bend of the waste-pipe forms a trap between the cistern and the drain, there is still considerable probability that the same danger exists.

The London water companies have more recently, with a view to preventing the waste of water, forbidden this connection between the waste-pipe and the drain, and have insisted that the former should be simply taken outside the building, and there cut off in such a position that any overflow or waste of water, the result of a faulty ball-cock, may be seen and remedied. This regulation is a very admirable one, for it not only prevents the improper waste of water, but serves to keep pure that which is in the cistern. Under all circumstances, the waste-pipe should be dealt with in this manner.

So much for the waste-pipe. But we have not yet considered all the opportunities the cistern has for the pollution of its water. It is common enough to find the water-closet supplied directly from a cistern which has also to furnish the rest of the house with drinking water. The cistern is at times empty, and thus an air communication is established between the inside of the cistern and the pan of the water-closet.

Water closets should be supplied from separate cisterns devoted to this purpose alone. At the present time, in some places, the water companies are enforcing the use of so-called waste-preventers; these are small cisterns supplied from another, and so constructed that they discharge readily the whole of their contents, but are themselves filled through so small a pipe that a second flush of the closet is prevented by the length of time which would be required for the waste-preventer to fill.

The accompanying drawings will serve to show the wrong and the right way of dealing with the cistern in relation to its waste-pipe, and the supply to the water-closet.

We have spoken of some of the risks of contamination to which water is exposed when supplied to a house through cisterns. It will be well to consider briefly the dangers attendant upon what is understood by a "constant service."

As we have already said, this method gives the best opportunity for maintaining a pure supply, inasmuch as the dangers of contamination which are special to the cistern are necessarily absent, the water coming direct from the company's mains to the taps in the house.

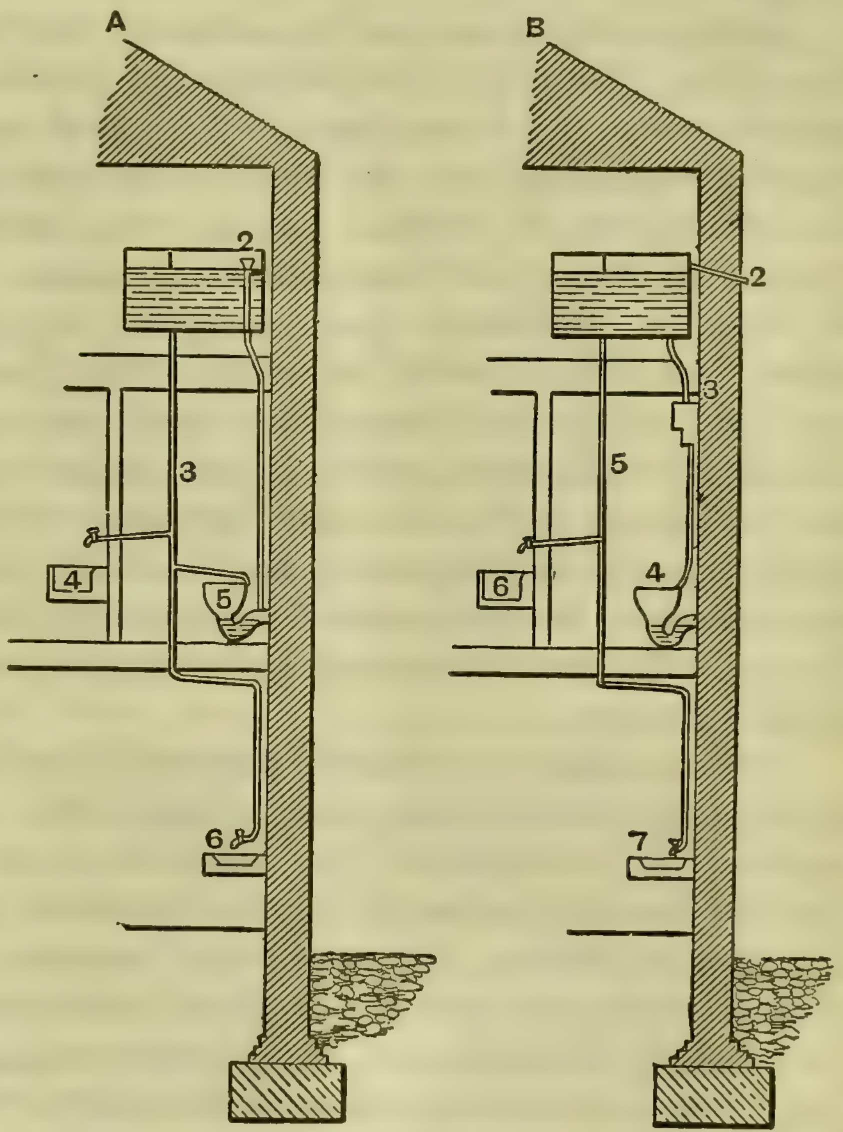

Fig. 2.—A. (1) Cistern; (2) Overflow Pipe connected with Soil Pipe; (3) Water Supply Pipe to (4) Housemaid's Sink; (5) Water-closet; (6) Scullery Sink. B. (1) Cistern; (2) Overflow Pipe discharging into open air; (3) Separate Supply and Cistern to (4) Water-closet; (5) Separate Supply to (6) Housemaid's Sink; (7) Scullery Sink.

The word "constant" must not be supposed to imply that the water is constantly "on;" there are times when, owing to some necessity for repairs in the company's mains or reservoirs, the service is interrupted. At these times, there is necessarily a tendency for the water in the smaller and higher pipes within the house to flow back into the larger pipes which are situated at a lower level, often underground. It is possible, then, if such pipes communicate directly with the water-closet, or other place where pollution may take place, for any matter situated at its orifice to be sucked back into the larger pipes or mains, and when the water is again turned on, to be driven into a pipe which supplies water for drinking purposes.

It was an accident such as this that led, in 1874, to an outbreak of enteric fever in Caius College, Cambridge. The water-closets in this college were supplied with water on the constant service. Each water-closet was provided with a safe to catch any splashings from the pan. This safe drained into the upper part of the trap of the water-closet, and was itself trapped by a bent pipe, which was kept supplied with water by a small weeping pipe, a branch of the supply pipe to the pan.

A water-closet was used by a student who had contracted enteric fever outside the college. The trap to the soil-pipe had, therefore, necessarily become polluted with enteric poison, and it was proved by chemical analysis that organic matter had not only been splashed into the trap to the safe, but had, at a time when there was an interruption to constant service, been drawn up the weeping pipe into the water-pipe beyond, and thus polluted the main. It is unnecessary for our purpose to follow Dr. Buchanan, who investigated this outbreak, and from whose report we glean these facts, into the argument which proved, with mathematical certainty, that the outbreak of disease from which the students suffered was caused by the introduction of enteric matter in this manner into the pipes which supplied water for drinking as well as for other purposes. But we give this reference to it for the purpose of showing one of the means by which drinking water can be polluted by a constant, though necessarily occasionally interrupted, service, when no service-box or small cistern intervenes between the water-closet and the mains which supply drinking water.

Filters.—Before leaving the question of water supply, we must say a few words on the subject of filtration, and, to begin with, we must point out that house filters ought not to be required. The water delivered to the house ought to be so pure that the householder should only be concerned in preventing its contamination in the pipes or cisterns. Unfortunately, however, the water may really need some further treatment; and under these circumstances, filters, if rightly used, will be found of service, but we would wish to emphasise the statement that where the house filter is not really necessary it is folly to have resort to it, for unless a good deal of attention is given to it, a further opportunity for contamination of the water is afforded.

Filters serve, in the first instance, to strain off from the water solid impurities which are floating in it, and they also serve to oxidise any organic matter in the water by exposing it to the air which the porous filtering material contains. To this extent the filter is capable of acting beneficially; but if kept constantly charged with water, it gradually becomes so laden with organic matter that it is itself capable of generating this material, and imparting it to water flowing through it. It is, therefore, necessary, from time to time, that the filter should have a rest for the purpose of completing the oxidation of the organic matter it contains. If it be made of charcoal, this should be cleansed by burning, or the filtering material should be changed.

The report of the Commissioners appointed to inquire into the best means of preventing the pollution of rivers speaks highly of *fresh* animal charcoal, silicated carbon, carbide of iron, and spongy iron; but the more recent experiments of Professor Frankland have tended to show that the iron preparations are far more to be depended upon than the others.

But we shall do well to close this section by cautioning our readers against trusting too much to the use of house filters, and we cannot do this better than by quoting the following words of the Royal Commissioners: "We desire it to be distinctly understood that, although this purification of water polluted by human excrement may reasonably be considered on theoretical grounds to be some safeguard against the propagation of epidemic diseases, there is not, in the form of actual experience, a tittle of trustworthy evidence to support such a view. Nothing short of abandonment of the inexpressibly nasty habit of mixing human excrements with our drinking water can confer upon us immunity from the propagation of epidemics through the medium of potable water."

Disposal of Waste from the Home.

Wherever animal life exists there will also be found the waste of matter concerned in its maintenance, and man, like the lower animals, tends to surround himself with the débris and effete matter produced by the wear and tear of his system; on the thoroughness with which this is disposed of will greatly depend his health. If his habits be those of the Asiatic, who permits large numbers of his kind to herd together, and, thus crowded, allows generation after generation to pollute the soil, he must expect to suffer disease in the same proportion as his Eastern brother, and to lose life as freely from causes of his own creating.

The refuse produced by animal life should not be permitted to saturate the ground, to poison the air, or to taint the water upon which man has to rely for food; it must be removed and dealt with in such a manner that under no circumstances can it at any time, from the moment of its production to the time of its ultimate disposal, be a source of danger or injury to him. If it be possible without harm resulting to convert it to a future use, this is desirable from an economic point of view; but with this latter point we have less concern than with that side of the question of refuse disposal which is associated with health.

Let us see for a moment what it is with which we have to deal. Every human being produces on an average from six to eight ounces of solid excreta, two pints of fluid excreta, and fouls by his ablutions, in the washing of his house, clothes, etc., many gallons of water which must be treated as waste. There are thus two kinds of materials to be disposed of, and whether these are to be kept apart or together depends upon the situation of the house.

System of Sewerage.—In some localities where a system of sewerage exists, the same sewer is permitted to receive the excreta and slop-water; in others, the sewer receives the slop-water only, giving rise to the necessity for the excreta to be kept as dry as possible, and to be mixed with dry earth or ashes, and to be periodically removed from the house.

We will first consider the position of the house where the sewer is permitted to receive the excreta and slop-water together. For this purpose it is connected with the house by means of drains; but this connection of a number of houses with the sewer, which is common to them all, exposes the inmates to risks against which special provision has to be made; for the sewer not only contains an amount of foul matter, but may receive into it poisonous matter emanating from persons suffering from communicable diseases. Much will of necessity depend upon the construction of the sewers, for if they are so made as to allow the contents to pass rapidly away, it is clear that their power for harm will be less than if they retain them. But the householder has no immediate control over their condition, and he must, therefore, take such precautions as are necessary to make his house independent of any fault in the sewer.

The drains must be laid in such a manner that they shall in no part of them retain any portion of the refuse which passes through them; they must, therefore, have a proper incline or fall, and should be laid upon a bed of concrete to prevent any disturbance of their position by the sinking of the earth. They must be made of some impervious material, and the points of connection of one length of drain with another should be carefully sealed to prevent their contents escaping at this point. As far as possible no part of the drain should pass beneath the house, and if this cannot be avoided, the drain should be encased in concrete.

Dangers of Sewer Air.—By an arrangement such as this, refuse can be removed from the house to the sewer without the escape of any portion of it in its course between the two. But a further danger has to be guarded against—the escape of the air of either the sewer or drain into the house. During recent years a great deal has been written about the effects of this air upon the health of people who, living in houses with imperfectly-constructed drains, have the misfortune to breathe it. Under the name of "sewer gas," it has been held responsible for the production of all the long list of infectious diseases, and indeed for almost all the diseases which are known as belonging to the zymotic class. At the present time, therefore, it is common enough to hear that some one is suffering from blood poisoning, the result of inhalation of sewer gas produced by an insanitary condition of the house in which he lives. It will be worth while to consider very shortly of what the air in a drain consists, and of what is really known of the result produced by its inhalation.

It consists of exhalations which are given off by the passage through the drain or sewer of the animal and vegetable matter which it receives; and if this matter be retained any length of time, it consists also of the results of its decomposition.

The late Dr. Letheby found that sewage which he permitted to decompose under a bell jar in his laboratory gave off gases as follows: marsh gas, 73·833; carbonic acid, 15·899; nitrogen, 10·187; sulphuretted hydrogen 0·081.

But in his experiment no air was allowed to enter; hence we must not assume that the atmosphere of a sewer contains anything more than a small proportion of these gases; marsh gas, indeed, as a rule, is not found, sulphuretted hydrogen and ammonia are found in traces, while carbonic acid is found to be in less proportion than ·4 per cent. In these proportions we cannot believe that these gases can exert an influence for harm if they were to escape into a house which was inhabited. But it is not to gases alone we must look for the cause of ill-health which undoubtedly results from the admission of sewer or drain air into the house, for together with them are found putrefactive germs, spores of fungi, etc., of which we must think with far more suspicion. We cannot point to one or another and say this will produce one disease, and that another; but we know that the escape of air from the drain under these circumstances will frequently lead to headache, sore throat, loss of appetite, and indeed general ill-health, and there are reasons for believing that even more serious consequences may happen from this cause. It has been observed that on more than one occasion an intense inflammation of the peritoneum was produced amongst those who have had special opportunity for the breathing of the emanations from such matter as passes into a drain, or for the drinking of water which has been exposed to them. Such an event happened some years ago in a school at Wandsworth, where a number of children were simultaneously attacked with this disease. The result was most disastrous, for not only did a number of the children themselves die, but Dr. Francis Edmund Anstie lost his own life while investigating the outbreak. On other occasions acute pneumonia attacking several members of a household has appeared to be associated with the same conditions. It is probable, too, that the emanations from putrescent animal matter, whether existing in a drain or elsewhere, may give rise to erysipelas, and in the lying-in woman to puerperal fever.

But having gone thus far we are left with but one other disease the existence of which is known to be related to such emanations. We refer to the disease known as enteric or typhoid fever.

In this disease the poison has been proved over and over again to reside especially, if not altogether, in the discharges of a person suffering from it. Under certain conditions, not yet very accurately understood, but possibly due to a further change in the excreta after they have left the body, the latter become poisonous in a high degree, and are capable not only of infecting water or milk, and thus communicating the disease to those who drink it, but of giving off emanations which will produce the same disease among those who inhale them.

Before leaving this branch of our subject, we ought to state very clearly that, so far as accurate medical knowledge can teach us, there is as yet an absence of evidence that the poison of the diseases diphtheria, scarlet fever, typhus, relapsing fever, or small-pox can originate in or be communicated by drains or sewers. It is not uncommon to hear some of these diseases, particularly scarlet fever and diphtheria, associated with defective drain construction. As a rule, the argument which supports this view rests entirely on the fact that a defect, either in the drainage or elsewhere, is found in a very large proportion of the houses in which such cases occur, and that no other circumstance can be assigned as the cause. It is unfortunately true enough that in very many cases the source of infection cannot be traced.

This, however, can be no matter of surprise, when we recollect the large number of persons suffering from mild attacks of infectious maladies, who, often unconscious of their condition, freely mix with their fellows. It would be unfair to conclude that the house is responsible for the disease, because defects are found coincidently with illness, unless it can be shown that a far greater proportion of the houses thus attacked with disease are imperfect than those which have escaped illness; this has never yet been done for these diseases, and we must remember it would be possible to find a house-defect accompanying almost every disease in existence, so carelessly and imperfectly are houses now constructed.

Nevertheless, it has been shown that a sufficiency of illness can be caused by the drain and its contents to encourage every intelligent householder to guard his family and himself from risks to which they are otherwise exposed. On the means of preventing the admission of drain air into the house it is now our intention briefly to dwell.

Means of Guarding against Admission of Drain Air.—We have already mentioned that the drain should as far as possible be laid outside the house, that the joints of the different pipe lengths should be sealed, and that care should be taken to prevent any sinking of the earth from disturbing the relative position of the various pipes. If these precautions be taken, neither the air nor fluid contents of the drain can escape at any point along its length. With a view to sealing both ends of the drain so that air may not escape from the sewer into the drain, or from the drain into the house, water traps are inserted; these consist of a bend in the drain so placed that the bend, A, holds water, which it receives in course of use, and which necessarily always stands up to the level, W. It will be seen that so long as the pressure of air in the drain does not exceed that which is capable of supporting a column of water equal in height to the distance between the lines W and B, the air of the drain will be retained in that position; but as soon as this pressure is exceeded, the air must pass through the trapping water and escape into the house. But a further difficulty may arise. The lower end of the drain-pipe may become filled with water which may pass so rapidly into the sewer that the water in the upper trap may by syphon action be sucked from its position, and thus until fresh water is poured in, the drain remains untrapped, and the air of the interior of the house is in free communication with the drain. This danger is overcome by the insertion into the upper end of the drain of a ventilating pipe, V, and provided that the calibre of this pipe is not less than that of the drain, it is obvious that in neither of the cases mentioned can the water in the trap be displaced. May we, then, assume that with a syphon trap and a ventilated drain it is impossible for disease-producing poisons to enter the house ?

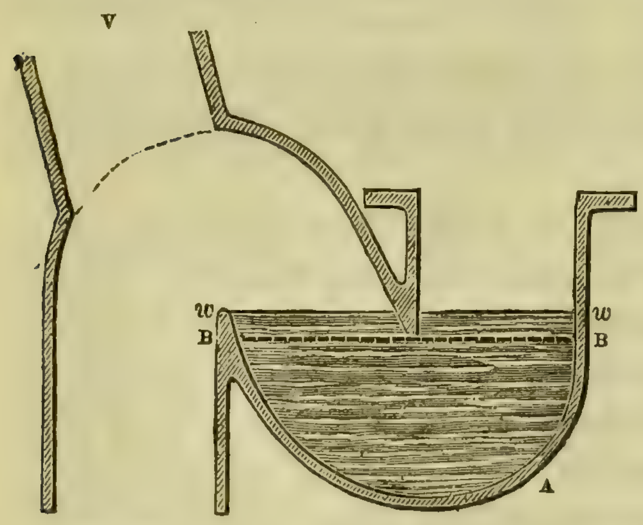

Fig. 3.—Syphon Trap.

Nature of Poison in Drains.—Before attempting to answer this question, it will be well to consider the nature of the poisons to which we refer. Are they liquid, solid, or gaseous?—and can they find their way into the water which is supposed to serve as a trap?—and if they can travel thus far, can they, under any circumstances, pass through the trapping water and mix with the air of the house?

We have spoken of certain gases which are given off as the results of decomposition, and which can be found in a drain through which excreta are passing. These gases are undoubtedly soluble in water, and would, therefore, be readily absorbed by the water in the trap, and might, by means of such evaporation of this water as would take place from its upper surface in a warm house, be received into the atmosphere; but we have said we cannot believe sufficient will accumulate to produce ill-health, even in persons who are specially susceptible to their influences, and though the water in the trap be seldom or never changed. The difficulty with which we are met is that we are without evidence that the specific poisons of such diseases as those against which we have to guard are gaseous. So far, indeed, as more recent knowledge of some other diseases enables us to guess at the form in which the poison of these diseases exist, there is more reason to believe that it is solid. Now, the evaporation of water does not appear capable of giving off into the air any particulate matter with which the water is charged; it must be admitted that the opposite has before now been stated, but a series of experiments have been carried out by Dr. Neil Carmichael, of Glasgow, which tend to prove that the former view is correct. Dr. Carmichael inserted into a soil-pipe a tube which was bent so as to hold water; to the further end of this tube he connected a flask containing cultivating fluid, which had been rendered sterile by boiling. The water in the bent tube soon developed fungi, but the cultivating fluid in the flask did not change during many months that it was under observation, the water in the bent tube always preventing the further passage of infective matter through it. Other experiments were made in which the air over the trap of a sink was drawn through cultivating fluid, precautions being taken to prevent this air containing any putrefactive matter that did not come from the trapping water itself, and yet the result was always the same—this trapping water invariably retained all the infective matter in it, and the cultivating fluid remained free.

Nevertheless there are ways by which particulate matter, suspended in a fluid, can be given off into the air. If by any chance air should be mixed with water charged with particulate matter, so that bubbles should be formed on its surface, the bursting of the bubbles will discharge into the atmosphere innumerable minute particles of water, carrying with them the solid matter. Thus Professor Tyndall found by experiments that the air of the Royal Institution, when allowed to bubble through concentrated sulphuric acid and a solution of caustic potash, carried with it organic matter which was capable of giving rise to fresh organisms when it afterwards came in contact with a suitable cultivating fluid.

It is difficult to believe that under certain circumstances this will not occur in the water contained in the trap of a drain, and it is desirable to ensure the water of the trap being as free as possible from such dangerous matter. The shape and material of the trap should therefore, be contrived that as little as possible of the excreta remain in it, and its cleanliness further provided for by an adequate flush of water, which ought to be sufficient to thoroughly cleanse the surface and to change the whole of the water which the trap contained. Moreover, the air in the drain situated between the trap which separates it from the interior of the house and the lower trap which disconnects it from the sewer should not by remaining stagnant in the drain become saturated with the emanations given off by the excreta.

An illustration of the harm which may result from the air becoming thus charged will serve to show that there is a practical reason for this recommendation. It was the writer's duty to investigate the cause of an outbreak of enteric fever which occurred in a model lodging-house. In this house there lived a number of families on different floors, having, as inquiry proved, no communication whatever with each other. Enteric fever broke out in a family residing in one of the upper storeys, brought by a person who had obviously contracted it elsewhere, and attacked one person after another, until some five or six had been seized with the disease. Shortly afterwards the disease appeared on a floor below, but no evidence could be found that the affected had been exposed to any source of disease outside the lodging-house. It was then seen that the soil-pipe, which had received the excreta of the sick persons on the upper floor, was also the soil-pipe for the use of those on the lower floors; an examination of it showed that, although it was provided with a ventilating opening at its upper end, there was at its base a large trap, which served not only its intended purpose of preventing air from the drain entering the soil-pipe, but also caused a retention of excreta within it. In this manner the poison of enteric fever was not only admitted into the soil-pipe by the infected persons on the upper floor, but was retained in a situation where it must necessarily have contaminated the whole of its air-contents, and there can be but little doubt was responsible for the illness which subsequently occurred.

Drain ventilation.—The one opening we have described as sufficient to prevent displacement of the trapping-water by an alteration of pressure within the drain is not sufficient to secure the exchange of air in the drain which is required for this purpose. We need not for proof of this refer to a better known example than that of the inability to suck an egg which has but one hole in the shell; a counter opening is absolutely necessary for the admission of air. So with the drain, a second opening must be provided to allow a current of air to circulate freely through it. This opening should of course be placed on that side of the lower trap which is nearer to the house, so that nothing should obstruct the current. The drain at this point is below the surface of the ground, and opportunity should, therefore, be given for the air to enter the drain by a pipe, which should be of the same size, carried a few inches above the earth's surface; and if it be possible for a manhole to be built at this point, this should be done, to enable the drain to be examined in the event of necessity arising. From the upper opening in the drain should be continued a pipe of the same size as the soil-pipe, and carried a few feet above the roof of the house. Fig. 4 represents the wrong and the right method of drain ventilation; in the one, A, there is no lower opening for ventilation, and a pipe of one-inch diameter is expected to be equal to ventilating the drain; in the latter, B, the ventilation is properly arranged (Fig. 4). It is not uncommon for this up-shaft to be crowned with a cowl, intended to extract the air from the drain, and thus ensure the passage through it of a constant current of air. A series of experiments were recently conducted with a view to ascertaining which of certain cowls would best perform this duty, but it was found that a simple tube permitted in a given time and under the same conditions more air to pass through it than those provided with cowls. Since that time other experiments have been conducted with apparently different result, but there is certainly on the whole not sufficient evidence to show that any benefit would accrue from their use.

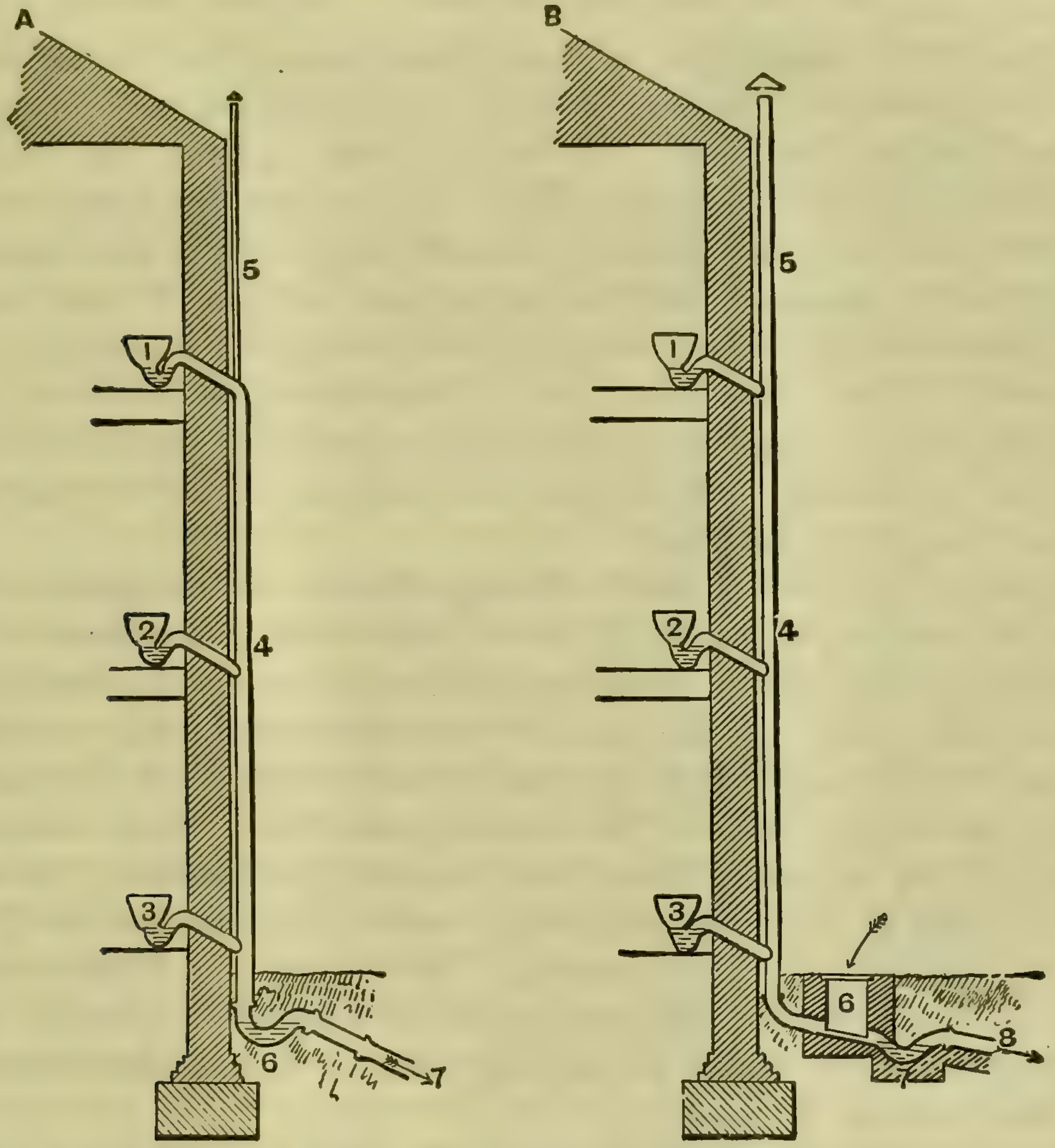

Fig. 4.—A. 1, 2, 3, water-closets; 4, soil-pipe; 5, 1-in. ventilating pipe; 6, trap at foot of soil-pipe; 7, drain. B. 1, 2, 3, water-closets; 4, soil-pipe; 5, 4-in. ventilating pipe, full diam. of soil-pipe; 6, disconnecting chamber with open grating; 7, trap; 8, drain.

A word must be given to the position of the ventilating openings we have described. Speaking generally, it is desirable that the lower opening should be removed as far as convenient from places where children would be likely to play, and perhaps put their faces close to it; but apart from this precaution, it need not be anticipated that the opening will itself give rise either to unpleasant odours or to injury to health if the drain be properly constructed. The direction of the current of air through this opening is more into the drain than out of it; but even if the current should occasionally set the other way, provided that the drain be well laid, there need be no expectation that an odour will be perceptible, for the air in the drain will through its constant change not be charged to any extent with effete matter. Placed in such a position as the area of a London street, they should not give rise to any unpleasantness.

As yet we have confined ourselves to discussing the best method of dealing with the solid and fluid excreta which have to pass from a house into a sewer; we must now briefly refer to the course which must be adopted for disposing of water from baths, lavatories, and sinks.

Waste-pipes.—The waste-pipes of these places should not be allowed to communicate directly with the drain or soil-pipe, but must discharge themselves over a gully placed outside the house, and which, itself opening into the drain, has between it and the latter a sufficient trap. The waste-pipes must be themselves trapped near to the baths and basins by other S traps, in the same manner as that we have described in connection with soil-pipes, and the best of these traps are provided with a screw at the bottom, which enables them to be cleared of the soap-suds which in course of time collect in them; if the waste-pipe be a long one, it will be well to carry from a point below this trap a ventilating pipe into the ouside air. Thus the same opportunity will be given for a current of air to pass through the waste-pipe as through the soil-pipe.

Much ingenuity has been shown in the manufacture of the apparatus best fitted to meet the requirements of health in the conveyance of refuse from the house. It is not our intention to discuss the advantage which one form of apparatus may have over another, more than to say that the pans of water-closets and other receptacles should be so designed as to ensure that every flush of water with which they must be provided should thoroughly remove the excreta, and leave them absolutely clean. Water-closets having containers should not, therefore, be tolerated; the shape of the trap should be such as to ensure cleanliness; and we may mention the D trap, loved of builders, as that to be specially avoided. The materials used have also a relation to the state of cleanliness of the pan, glazed earthenware answering well in this respect. With regard to sinks, we may say that no more suitable material than slate or earthenware can be used.

The particular apparatus to be used is fully dealt with in many books on the subject, but having indicated the general principles which shall guide those who wish in the arrangements of their home to have regard to the health of the inmates, we need not do more. We must now briefly refer to the precautions which it is necessary to take in dealing with surface or subsoil drains. These should not in some situations be permitted to depend upon rain-water alone for the maintenance of the water which is required to keep their traps charged, but should, where possible, be supplied with water from an adjoining bath or lavatory waste. Subsoil drains beneath a house particularly should not communicate directly with the sewer, but should be disconnected in the same manner as waste-pipes, while the maintenance of water in the traps should be ensured in the same manner as in surface drains.

In London the enforced use of waste preventers by the water companies, which limit to two gallons the amount of water which can flush a water-closet at one time, is calculated to lead the householder to expect that this amount of water is sufficient to answer every requirement; but it has been found by those competent to speak with authority on this point that so small a quantity will not thoroughly cleanse the pan, trap, and soil-pipe, especially where the last is of any length. This amount must, therefore, be supplemented by the throwing down daily of a pail or two of water.

Cesspools.—In London, and many parts of the country before sewers existed, it was customary to provide every house with a hole, or cesspool, into which all the excreta and slop-water escaped. These were, of course, from time to time emptied of their contents; but after what we have said of the danger to health caused by the accumulation of such matter in drain-pipes, no further illustration will be required to show the extreme risk of such a method of refuse disposal. Often placed under the basement of a house, a situation in which too many are to be found even at the present time, abundant opportunity was given for their emanations to escape into the house. In many instances they are simply holes dug in the earth, so that there is nothing to prevent their contents saturating the surrounding ground; but even when removed far from the house, and built of substantial brick-work and cement, this method is one which cannot meet with approval, for it does not do more than permit the accumulation of the excreta, which have subsequently to be removed, and this at a time when, owing to decomposition, they are more than ever offensive. Under any circumstances, the fact that the cesspool is below the ground renders it a source of danger, for from time to time the contents are likely to escape, owing to some accident or other, and thus, perhaps, lead to the pollution of some well in the neighbourhood. The least offensive form of cesspool is that which is very limited in size, so much so as to merit the name of catch-pit rather than cesspool, and provided with an overflow, to permit its more fluid contents to flow through irrigating pipes into the ground; but this, of course, is only possible where the house is well surrounded by land. If cesspools are to be permitted to exist, they should be situated at least thirty or forty feet from any occupied building, or from any water used for domestic purposes. The cesspool should be built of brick-work, set in cement, and lined inside with the same material, and at least nine inches of well-puddled clay should be rammed beneath and around it, or other means should be taken to prevent the contents escaping. It must be properly covered over, and be ventilated directly into the air, and means must be provided by which access shall be obtained, so that it may be readily emptied.

Dry Systems.—A better plan than the last when there are no sewers, especially where houses are congregated together, is to keep the slop-water from the beginning entirely distinct from the excreta. This is the method adopted in some of the large north-country towns, and where are several plans of dealing with excreta.

First, the *midden privy*, a receptacle for excreta and ashes, which should not receive slop-water. Formerly the midden resembled the worst form of cesspool in its construction, but is now much improved. As much care is required in the details of its construction and in its situation as in the case of cesspools. It should be above the ground, should be emptied very frequently, and it is recommended that it shall not have a larger capacity than eight cubic feet.

An improvement upon the midden is the *pail system*, which should also receive only the excreta and ashes; here a pail replaces the midden. In some towns, by an ingenious arrangement, the fine dust of the ashes finds its way into the pail, while the larger cinders fall in another direction, so that they can be otherwise utilised. A further contrivance enables a lever in connection with the seat, immediately after use, to discharge into the pail a sufficiency of fine ash.

A third method, known as the *Goux* system, is intended to cause the immediate absorption of the more liquid portion of the contents of the pails. For this purpose the pail is lined inside with a composition of dry refuse, ashes, and clay; in other respects it resembles that already described.

Efforts have been made to deodorise the excreta by means of *charcoal and dry earth;* the latter method has been in every way so successful that it deserves a few words of special notice. It is found that one and a half pints of dry earth is sufficient to completely deodorise a single dejection. The effect which the earth produces is probably something more than that of a deodorant, for a complete change rapidly takes place in the material which is acted on to such an extent that its original composition is in a short while not capable of recognition. It is essential that the earth shall be very dry and finely sifted, and, with the exception of sand, any earth may be used, although that of a loamy character is best suited for the purpose. The late Rev. Henry Moule, by whom this method was chiefly brought to the notice of the public, has designed an admirably-contrived earth-closet, consisting of a wooden seat, beneath which is a pail; the back is hollow, so as to contain a quantity of earth, a sufficiency of which is discharged either by the action of the seat or by the use of a plug on each occasion that the closet is used. The contents of the pail must be stored in some situation where they are protected from wet. After a while the material may be again employed for the same purpose; it has, indeed, been used six or seven times without any indication of failure. It is then of value for manurial puposes, and may be well employed on a garden. Whether this earth may be trusted to destroy the poison of the excreta of enteric fever has been, perhaps, not yet conclusively shown; but it may be stated that it has now been largely used for many years, and for many thousands of persons, and yet there is not the least evidence of any disease having been associated with its use. On but one occasion has any accusation been brought against it: when first used, it was believed by some to have been the cause of an unusual prevalence of diarrhœa in the camp at Wimbledon, but evidently without any foundation, for its subsequent use under the same circumstances has not been attended with similar illness. There does not appear to be any reason why the earth-closet should not be used inside a house. To be successful it must be properly treated, and must on no account receive slop-water. For ordinary house use a sufficiency of earth can be dried over the kitchen fire or in the sun.

Disposal of Slop-water.—The dry methods of refuse disposal have the disadvantage that we must make some further arrangement for getting rid of slop-water. How this should be done must depend upon whether the house has a somewhat isolated position with sufficient land on which the water can be used for irrigation, or whether it is situated in a town closely surrounded by other houses, and without sufficient land for the purpose required. Under the latter circumstances, it becomes necessary for the town authority to provide by drains or sewers some means by which the water can be removed. Where the town authority undertakes this duty, the only point for us to consider is the relation of this drain to the house. If the drain be permitted to enter the house, the same care must be taken for its effectual trapping and ventilation as in the case of drains which are to receive excreta as well as slop-water; but it should be remembered that there is not the least necessity for the drain to be brought nearer to the house than is sufficient to enable the sink and bath wastes to discharge themselves outside the house over a properly-trapped gully in communication with the drain. The means for ensuring the proper cleanliness of these waste-pipes has been already described.

If the house has to make its own arrangements for disposing of slop-water, it may be carried to some receptacle a short distance from the house, and then used for watering the garden; or it may be distributed by means of irrigation pipes to different parts of the garden just below the soil. The amount of fluid which the earth will absorb, and which can therefore be got rid of, will depend upon the character of the soil, but it has been found that this amount is influenced by the manner in which the water is discharged into the earth. If the earth receives the water in a constant dribble, the latter will penetrate much less distance than if poured into it in larger amounts and allowed an interval of rest between each flow. The flush-tanks, designed by Mr. Rogers Field, are exceedingly well adapted to secure the intermittent discharge of water into the soil.

If we were able to choose the method of refuse disposal which we should prefer, we should select the water-carriage system as the one which, with the least trouble and with the least unpleasantness, removes both excreta and slop-water from the house. If, on the other hand, we were obliged to adopt one of the dry methods, we should undoubtedly prefer the dry-earth system to any other.

But the choice of these different methods must to some extent depend upon other considerations than those of health and decency. The situation of every town does not permit it to adopt the water-carriage system, nor is it possible for a town which has all the necessary appliances, and is accustomed by habit to any one system, suddenly to revolutionise its method of procedure; but it is possible, by a careful attention to the construction and situation of apparatus, and to the best manner of its utilisation, to reduce very considerably the disadvantages attendant upon the adoption of any of the methods we have mentioned; and we cannot do better than refer our readers who wish to learn how this may best be done to the admirable model bye-laws of the Local Government Board intended for the guidance of sanitary authorities.

House Dust.—We have now to say a few words concerning kitchen and household refuse, which in London is known under the name of "dust." We have already made brief reference to some of the uses to which the material may be put where the dry method of dealing with excreta is adopted, but in many large towns, particularly in London, the whole of the house dust is removed and subsequently put to other uses—to the manuring of ground, and to the making of bricks. Unfortunately its removal from the house is, as a rule, in the hands of contractors whose desire to obtain it is dependent on their need for it, and, inasmuch as it cannot be utilised equally during all seasons of the year, there are times when it is allowed to remain in the dust-bins, where it is necessarily a danger to health. The householder is dependent upon the action the local authority will take for securing its removal, and he is therefore compelled to make provision for it to remain for a varying time on his own premises. It is, therefore, his policy to render it as innocuous as possible, and with this object he should sedulously control the material which is permitted to be thrown into the dust-bin.

The dust-bin should receive nothing but dry dust and dry ashes; all organic matter, meat, bones, and vegetable refuse should be burnt. In this manner he will not only prevent the creation of a pestiferous mass within the precincts of his dwelling, but he will to some extent make himself independent of the delinquencies of the local authority by reducing the bulk of the material for the removal of which they are responsible.

The dust can be best and most conveniently stored in a zinc or galvanized iron pail or receptacle; this should be movable, and may with advantage be provided with a sieve, which will enable the half-burnt cinders to be employed again. The receptacle should be placed under cover to shelter it from weather, and situated where it is accessible from the house, but not within it. Its capacity must, of course, depend upon the size of the house, but experience has shown that one measuring two feet in height and two in diameter is capable of containing for a week the house dust of a household in which five or six fires are constantly burning during the day.

VENTILATION AND WARMING OF THE HOME.

It is somewhat remarkable, seeing how readily we are prepared to admit the effect for good or bad of the food which we daily eat and drink, that we should give so little thought to the quality of the air which in vast quantities is every moment entering our body and influencing its condition. We recognise that the atmosphere may, by some accident, be so altered in its character as to be immediately destructive of human life, and we may recall to our minds the Grotto del Cane, near Naples, where no human being or animal can live, or the deadly choke-damp of the miner, which is so often destructive of life. But beyond extremes such as these, little thought is, as a rule, given to those lesser variations in the condition of the air which, though more slowly, yet not less certainly, interfere with health and life.

We need not do more than state in proof of this assertion that it is possible for the death-rate, from diseases of the respiratory organs, in one locality in England to be more than three times the death-rate from the same diseases in another. It may be impossible for those of us who live in large towns to obtain the same pure air as those who dwell in country regions; but there is no difficulty, through faulty construction, in making the air of our dwellings, however well situated, as unfit for respiration as those of the worst towns. Take, for example, the different rates of mortality in those localities where the poor are crowded together, and where ample space is allowed to every individual; there, in the same town, will be found a difference just as there is between some of the best and worst parts of the kingdom.

Evils of Want of Ventilation.—We may, in passing, with a view to showing what bad ventilation can do, refer to the terrible mortality amongst infants at the end of the last century in the Dublin Lying-in Hospital. In this institution, for every three children born, one died within the first fortnight of life from causes which arose from bad ventilation alone; this was clearly shown, for an improvement in the ventilation led to a reduction in the number of deaths by nine-tenths. A further lesson may be learnt from this same institution. It is the young who chiefly suffer, and thus we find that much of the higher mortality of the crowded dwellings of the poor is due to mortality among infants and young children. One other instance of the evil effects of deficient ventilation may be quoted—that of the high mortality from phthisis which formerly prevailed among the Guards, which was believed to be due to the ill-ventilated barracks which they occupied : an opinion confirmed by the fact that when the ventilation was improved the disease greatly diminished.

Our dwellings must, then, be so constructed that the air within them which we breathe shall not be more impure than the source from which it is drawn, and it must be distributed in such volume and in such manner that, while supplying us with all the air we need for respiration, it shall not in any other way produce ill-results. It is, therefore, necessary in the first instance to ascertain how much air is required, and, in the second, how this may be best obtained.

Composition of Air.—Normal air consists of 79 parts of nitrogen and 21 of oxygen, or slightly less than this, for Dr. Angus Smith has shown that in towns there may be as little as 20·90 of oxygen, while in country districts, 20·98. There is also an amount of carbonic acid, varying from two to five volumes in ten thousand. The air, moreover, contains a certain amount of moisture, which varies very considerably, that most conducive to health being, probably, from 65 to 75 per cent. of saturation (Parkes).

The variation in the amount of oxygen appears to have very much less influence upon health than the proportion of carbonic acid which is present.

This is the composition of air before it has been breathed, but after respiration great changes have taken place ; as much as 4½ per cent. of the oxygen is abstracted and is replaced by almost as much carbonic acid. Whatever the temperature of the air has been before inspiration, after expiration it is always between 97° and 99½° Fahrenheit, and however much moisture it contained before, it is afterwards nearly saturated. It has, moreover, a small amount of ammonia, and of organic matter.

The amount of air which undergoes these changes varies very much in the same individual when he is taking exercise and when at rest; for our purposes we may assume that the inmate of a room is at rest, and, therefore, about 400 cubic feet of pure air becomes polluted to the extent mentioned in twenty-four hours, and, being discharged into the room, pollutes this, although to a less extent, by mixing with it. As yet, we have only spoken of the carbonic acid as an impurity, but we must bear in mind the amount of animal matter which is also given off by every human being ; it is, however, generally accepted that the amount of carbonic acid forms the best index of the condition of the atmosphere of a room. This question has been very carefully worked out by the late Dr. Parkes and by Professor de Chaumont, who found that the organic impurity of the air is not perceptible to the senses until the carbonic acid rises to the ratio of ·6 in 1,000 volumes, but beyond this point the air commences to become perceptibly impure. The result of a series of analysis of the air was presented by Dr. de Chaumont to the Royal Society, and classified as follows:—

In every 1,000 *Volumes.*

0·19	of carbonic acid	was found	pure.
0·41	,,	,,	rather close (organic matter becoming perceptible.)
0·67	,,	,,	close (organic matter disagreeable.)
0·90	,,	,,	very close (organic matter offensive.)

showing that ·2 volumes of carbonic acid per 1,000 is "the maximum amount of respiratory impurity admissible in a properly-ventilated air-space." This, it must be remembered, is not the total amount of carbonic acid in the air, which, as we have pointed out, varies from ·2 to ·5 volumes in every thousand, but is the amount which is superadded to an average initial impurity of ·4 volumes in every thousand by subsequent respiration.

The problem that concerns us is, how frequently air must be changed to prevent the rates of carbonic acid due to respiration being increased more than ·2 volumes in one thousand.

Cubic Space Required in a Room.—Every average person produces ·6 of a cubic foot of carbonic acid every hour; if, therefore, such a person were to enter a room of 1,000 cubic feet capacity, it would be necessary to add 2,000 more cubic feet of air than that the room already contained to reduce the impurity to the limit of ·2 per thousand. At the end of the first hour he would continue to want 3,000 cubic feet of air during every subsequent hour to dilute the ·6 of a cubic foot of carbonic acid which he would be giving off to ·2, the highest amount which is to be allowed in our room of 1,000 cubic feet. So if the room were of half the size, the carbonic acid would have a tendency to collect at twice the rate, and would have been in the proportion of 1·2 cubic feet in 1,000 if no other air had been admitted; it is, therefore, necessary to add during that hour as much more air as will make the total amount equal to 3,000 cubic feet, so as to prevent the impurity of the carbonic acid increasing beyond ·2—that is to say, that to the 500 cubic feet must be added during the first hour 2,500 more, and for every subsequent hour 3,000 cubic feet.

Now, if the room contained 500 cubic feet of air, the whole of its atmosphere would have to be changed six times in an hour to prevent it becoming close, but the result upon the occupant would not be altogether agreeable, for he would be conscious of the current in which he would be placed. Air may travel at the rate of ninety feet per minute without the current being felt, and if we were to make openings into the room of a sufficient size, it is obvious that we could easily change the air of such room six times in an hour without such a limit being reached, but it is equally obvious that we are dependent in all houses upon very small openings for the admission of air, and it is found by experience that if the air is changed more than three or four times an hour draught is produced. We must, therefore, allow to each individual so much cubic space that it will not be necessary for him to have the air changed more frequently than this number of times, and he should therefore have something approaching to 1,000 cubic feet for this purpose.

In practice this amount of air-space is not allowed, and the greatest variation is found in the amount deemed necessary by different individuals; thus, some of the Metropolitan Sanitary Authorities are satisfied that there is no overcrowding in a dwelling-house if for every adult in a room used by day and night there are 300 cubic feet, and for every child under twelve half that amount. In workhouses, the Poor-law Authorities require 360 cubic feet for each person in a dormitory, and 500 feet if the room is to be used by day and night. For ordinary sick, 600 cubic feet are required, for lying-in cases 960, and for infectious diseases the Sanitary Authorities require 2,000 cubic feet.

It need hardly be pointed out that the limit of 300 cubic feet is altogether insufficient; even the Poor-law Authorities insist upon a larger amount in well-ventilated wards, which are, as a rule, provided with opposite windows; how much more deficient, therefore, is the limit of the Sanitary Authorities for rooms which have far less opportunity for systematic ventilation!

A point must be referred to here in connection with the measurement of air space. The Poor-law Authorities do not allow any space above 10 feet from the floor to be reckoned as a part of that allotted to each individual; but in asking for the larger amount of space which we believe to be necessary for health in a dwelling-house, we may extend the measurable space to 12 feet from the ground, and we shall not be demanding more than health requires if we claim about 80 square feet of floor-space for each person.

Effects of Artificial Light upon the Air.—As yet we have only considered the effects produced on the atmosphere by man, but we must also make allowance for the changes caused by the production of artificial light. One jet of gas, for instance, will give out as much carbonic acid as about six men; with candles the result is different, but Dr. Odling has taught us that were we to have as many candles as would give the same amount of light as the gas, the result on the air would be the same. In ventilating our rooms, therefore, provision has to be made for this further consumption of air.

We have now considered the amount of air we shall want, and the next part of our problem must consequently be to ascertain how this exchange of external and internal air is to be effected.

Natural Ventilation of Rooms.—We shall not attempt to discuss those artificial methods to which resort is sometimes had for the ventilation of large buildings, but shall confine ourselves to a brief account of the conditions concerned in natural ventilation, for which we are dependent upon the difference of the specific gravity of the air inside and outside the room.

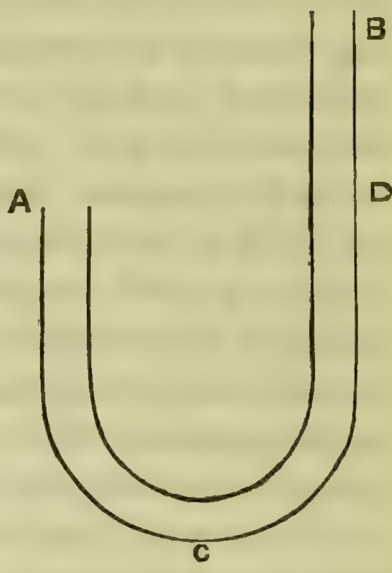

Fig. 5.

It is a well-known fact that all gases, air included, are increased by $\frac{1}{480}$ of their volume for each degree the temperature is raised from 32° Fahrenheit. Now, the air coming into a room is colder, and therefore has a higher specific gravity, than the warmer air leaving it. If we could place the two airs in a bent tube so that the colder air should occupy the column A C, it would support a column of the warmer air equal to B C, having a height, B D, greater than A C. Under these circumstances the air would enter the orifice A with a velocity equal to that which would be attained by a body falling through a distance, B D; that is to say, equal in feet per second to eight times the square root of the distance B D, but in practice it is found that in the case of air entering rooms through tubes a deduction of $\frac{1}{4}$ has to be made on account of friction. Upon the difference between the external and internal temperature, therefore, and upon the size of the openings, must the ventilation of the room depend.

The most complete system of ventilation is that which would admit fresh air into the room at our feet, and allow the vitiated air to escape at the ceiling, but this in practice is often found impossible, because the air when admitted is cold, and a current of cold air near the feet is unpleasant and prejudicial to health. Efforts may be made to overcome this difficulty by heating the air at the point of admission by hot-water pipes, but in a large majority of houses this is not easily accomplished. In most rooms of moderate size, we have certain fixed conditions to deal with: there are windows communicating with the external air, a door opening on to a passage or staircase, and a fire-place—all of these giving opportunity for the inlet or egress of air. In the summer we can readily obtain a free current of air through the room by opening the windows and the door; in the winter, when the fire is lighted, we are provided with a hot-air shaft, which rapidly carries off the air-contents of the room, and we have only to arrange for the inlet of air for the purpose of effecting a change in the atmosphere of the room.

The ordinary method of ventilating a room is to open a window at the top, the impression being that, inasmuch as the hot air ascends to the ceiling, it will readily escape through the open window. The result is, however, very different; the heated air in the room is of so much less specific gravity than the outside air that the latter will immediately rush in and descend towards the floor of the room, finding its way towards the fire-place, and thus escaping up the chimney. But the descent of a current of cold air upon the heads of the occupants is as disagreeable as its admission at their feet. Measures must, therefore, be taken for directing the current in such a manner that it shall not fall immediately to the floor, but shall be admitted at such an angle that it shall find its way to the ceiling, and there being broken up shall descend so gradually towards the floor that no draught is appreciated by the inmates. For this purpose it often will not do to trust to one inlet opening, the current under such circumstances being too strong and being limited to too small a portion of the room; but if the current be subdivided and admitted at different parts, the exchange of the whole atmosphere of the room is more thoroughly effected.

From what has been said, it will be seen that the best results are obtained by directing the air currents on their admission immediately upwards; in the window this may be done by cutting a slit in the bottom of the upper sash, or by raising the lower sash a few inches, and filling up the vacant space between its bottom and the window-sill with a movable board, the air current thus passes between the bottom of the upper sash and the top of the lower sash in an upward direction; but these methods by themselves are not always sufficient, and it becomes necessary to consider the position of the room, if further openings are to be made.

The Sherringham ventilator will be found useful for the inlet of air through an outside wall, for it not only directs the current towards the ceiling, but can be opened or closed to the desired extent. If it be necessary to provide other means for the escape of air than is afforded by a chimney shaft, a simple shaft from the ceiling carried upwards will give such opportunity; or in a room with a fire-place and chimney, the introduction of an Arnott ventilator into the chimney near the ceiling will assist in the exit of the foul air in this direction.

Where, however, the room has not more than one outside wall, it may be necessary to admit air into some portion of the room which is furthest from the external wall; it is under such circumstances that the use of tubes, which are now most frequently associated with the name of Mr. Tobin, will be found advantageous. The air is admitted through a horizontal shaft, communicating directly with the external air, and carried beneath the floor to that part of the room into which it is proposed to admit air; at this point the tube turns at right angles, and is carried up inside the room to a height of above five feet. If there be much difference between the temperature of the outside air and the air inside the room, a column of air ascends from the inlet and passes unbroken until it reaches the ceiling, but the value of such an arrangement is almost altogether dependent upon the difference of temperature, and hence, in summer weather and with the windows open, the tube will be inoperative, but, it will be remembered, it is not then required. The tube can be closed at will, it need not necessarily be made unsightly, and its use is indeed attended by but one drawback—viz, the tendency for dust to collect within it and render the air less pure. The diameter of the tube, like all other openings, must depend upon local conditions.

We have already considered the amount of air which is required to replace that consumed by each individual, and by candles, gas burners, etc. The requirements for every room will be constantly varying, and there is, therefore, considerable difficulty in deciding the amount of opening which will be necessary at one time and another; but if we accept, with Dr. Parkes, that twenty-four square inches for inlet, and the same for outlet, be allowed for each individual, and arrangements be provided for reducing this in very cold weather, we shall be adopting a mean best suited to the varying condition of an English climate.

No one, however, can properly ventilate a room without bearing in mind the principles of ventilation which we have endeavoured to explain in this chapter. They must guide him in the number, the size, and the position of the openings which are to be made, and when this much has been accomplished, the same thought must be applied to their subsequent management. For as the conditions which have to be met necessarily vary from one time to another, so must the means for meeting them vary also. It will, however, be well to be prepared for those times when the largest demand will be made for air rather than to limit our preparation for occasions when less is required, and thus we shall be in a position, by controlling any excess, always to ensure that the atmosphere we are breathing is best adapted to the needs of health.

Warming of the Home.—It has been impossible to discuss the question of the ventilation of the room without referring to its warming at the same time, but it is necessary to devote a small portion of the space at our command to a fuller consideration of the latter subject. We have, however, limited ourselves to describing the effects which are produced by an open grate and its accompanying chimney, because, as a rule, it is by such means that rooms in this country are chiefly warmed.

But the warmth of a house may be maintained by one of two methods: either by *radiant heat* from a fire-place or stove or hot-water pipes situated in the room, or by the admission of air which has itself been previously heated. By the first, solid bodies situated in the room are warmed by the rays of heat which fall upon them, while the air to a very great extent escapes their influence; by the latter method, solid bodies are warmed by coming in contact with air which in this case is itself heated. But which, we must ask ourselves, is the method best suited to health? This is a question which is not easily answered, but if sensation may guide us in forming an opinion, we shall without doubt accept the former, for the inhalation of warmed air produces a feeling of lassitude and drowsiness which is not experienced when unwarmed air is breathed, and the warmth of our bodies maintained by radiant heat.

Nevertheless, we are not prepared to recommend that warmed air should under no circumstances be used. The enormous waste of heat by its escape through the chimney of an open fire-place is a point which must be remembered, and in all probability the best arrangement is that which, including all the advantages of radiant heat, gives facilities for the warming of some portion of the air entering a room. In small rooms this is unnecessary, but in large rooms occupied by many people, where it is necessary to change the air very frequently, draught may be best avoided by allowing some portion of the air to be warmed on admission.

Such stoves as that designed by Captain Douglas Galton will well answer this purpose, and have the additional advantage of carrying off some of the vitiated air which fails to find its way up the chimney shaft.

But where any amount of warmed air is admitted, the necessity for preserving its moisture must be recollected, for there is no doubt that much of the unpleasantness resulting from its use is dependent upon its dryness.

Gas Stoves.—A brief mention must be made of gas stoves as a means of heating. These are chiefly used in combination with asbestos or coke, which they maintain at a red heat. So far as health is concerned, there are but two points to be observed in connection with them: first, that they shall be supplied with a sufficiency of air; and, second, that the products of combustion shall be at once removed from the room. The use of gas for heating purposes is increasing rapidly, and will doubtless in the future play a more important part than it does now in the warming of our rooms; but its use, provided the above requirements be fulfilled, is dependent rather upon economic than health considerations, and we need not, therefore, dwell further upon them here.

Whatever means are used for warming our house, we have but one object to attain—viz., the maintenance of a temperature in parts occupied by day of from 55° to 65° Fahrenheit; at night, when people are in bed, a much lower temperature is readily borne without interference with health, but exception must be made for old, feeble, and very young people, whose powers of maintaining the warmth of their body is much less than that of those of middle life.

Whether people are up or in bed, they will continue to need a supply of air for breathing purposes, and the ventilation of the room must, therefore, never be sacrificed for the maintenance of warmth; hence, no room should be occupied which does not provide ample means for the escape of vitiated air and the admission of fresh air. By the flues in connection with our open fire-places there is abundant opportunity for the maintenance of a current through the room, provided the admission of air be arranged for.

A word of caution, however, is required to prevent rooms which are constructed on the best principles from being rendered unfit for occupation by the carelessness or thoughtlessness of their occupants. The frequency with which the fire-place in the bed-room is closed by a board when not in use deserves notice here, but we trust a recognition of the necessity for the purposes of health of thorough ventilation will soon lead to a disappearance of the *fire-board* from the house.

THE LIGHTING OF THE HOME.

We are too much accustomed to think of light merely as an aid to sight—as the something which is necessary to enable us to find our way about the world, and perform those duties which we are called upon to undertake. But the relation of light to our existence is a much larger one than this, for the sun's rays contain elements which go far beyond the mere illumination of objects, and are concerned in the production of chemical changes in all living beings, both animal and vegetable.

Chemical Effects of Light.—Numberless experiments have shown the necessity of these chemical rays for the proper growth of plants; and there is no manner of doubt that man is also dependent upon them for the full development of health and strength. Many years before the composition of the solar spectrum was understood, the value of the health-giving properties of light was believed in, and the solar baths of the Romans are evidence that two thousand years ago sunlight and health were known to be closely associated.

In our time the advance of scientific knowledge is making us think of sunlight as perhaps one of the means of preventing disease. We may yet, perhaps, fail to fully understand the bearing of the more recent observations of Professor Tyndall, but it is impossible to refrain from the belief that a series of experiments conducted to show the influence of sunlight upon decomposition will have in the future a bearing upon health of the most important character. He found that fluids specially prepared for the development in them of living organisms which accompany decomposition were affected by exposure to the sun's rays; flasks charged with these fluids and exposed to sunlight remained more free from these organisms than those which were kept in the shade; nor did this freedom last only during the period of exposure to the sun, but the fluid obtained a power to prevent the development of life during the nights which intervened between the days. Flasks, however, which were not exposed at once became turbid from the production of animal life.

Similar experiments, conducted by Dr. Dounes and Mr. Blunt, led to the same result, and showed that the preservative quality of light was most powerful in the direct solar rays, but that it could be demonstrated to exist in diffused daylight.

Sunlight therefore appears to serve the double purpose of aiding the growth of those organisms which are necessary for man as well as of man himself, while it retards the production of others which are antagonistic to his existence.

A recognition of this law teaches us that health in our home is dependent upon the use to which we put the light which is given by nature equally to us all. Thus we learn that Mr. George Macdonald's pretty allegory "Photogen and Nycteris" is not without its lesson, and we may well believe with him that the sun plays no small part in the development of man's mental and physical condition.

But we have only to visit the sunless courts which are to be found in the poorer quarters of every large city to convince ourselves that want of light is by no means the least of the causes which tend to produce pale faces and low vitality in the inhabitants of these districts. The lesson we may there learn must be applied in our own home if it is to meet with all that health demands.

Desirability of an Ample Supply of Light in Rooms.—Let us turn from the theoretical to the practical bearing of this subject: if we have the opportunity of arranging the aspect of the various rooms, we must be guided by the use to which it is intended to put them. Rooms in which we are to dwell must be so placed as to receive a maximum of light during the day; sleeping rooms, which are occupied at night only, must, therefore, give place in this respect to those which are inhabited by day. But even in such an arrangement as this must be remembered the certainty that sickness cannot be always absent from a house, and that the time will come when one or more bed-rooms must be devoted to those who will require sunlight even more urgently than others who are not confined to one room. Probably it is among the sick more than any other class that the effect of light is more easily seen, for it is no rare experience to those who have lived in hospitals to find a long and tedious illness begin to abate from the moment the sufferer is removed to some spot where he can take in more life from the source from which all life springs.

Unfortunately in England we rarely have to complain of excess of sun, and we shall be acting wisely by increasing our means of temporarily excluding it rather than by arranging our rooms in such a position that it cannot enter them.

Size of Windows.—The position of the window is not the only point for consideration; its size is a no less important matter. Various rules have been laid down by architects for regulating this point, depending usually upon the size of the room which has to be lighted. The model bye-laws of the Local Government Board require a window space of one-tenth of the floor area of the room. If any fault is to be found with this rule it is on the score of insufficiency. The only objection to excessive window space that can be found is the loss of heat, which results from the thinness of the glass, and any imperfections in the fittings; but these can be remedied by the use of plate-glass, by double windows, and by better workmanship, while the methods for introducing increased light—such, for instance, as through a given aperture by the use of reflectors—are at the best very unsatisfactory.

We have now to consider the use of *light in its relation to the eye.* In an admirable article on Lighting, in "Our Homes, and How to Make them Healthy," Mr. Brudenell Carter has well described the evils which result from insufficiency of light, and has shown that it necessarily leads to books and other objects being placed nearer to the eyes than in the case where light is abundant; in this manner short-sightedness is induced, or where it exists already is further increased. He also points out the disadvantage of carrying the window so near to the floor that rays of light will enter the eye from below, where it is not protected by eyebrows and eyelashes to the same extent as above. French windows should, therefore, be avoided, or the lower part filled in by some non-translucent material.

A few words may be said concerning the position of the inhabitants of the house with regard to the windows. Experience will have taught most of us the desirability of not placing the bed opposite to the window, and of so darkening the room as to prevent the morning light awakening the sleeper before the time for rising has come. But the relative position of the window and the individual is not confined to the hours of sleeping, for, as Mr. Carter has well shown, it is prejudicial to do close work, such as writing or needle-work, immediately in front of a window. The best position for the light is at the left side of the worker, so that the right hand which is employed does not throw a shadow upon the paper or work, and so that the necessary raising of the eyes which takes place from time to time does not expose them to the glare of light. These may appear small considerations, but they have a very distinct bearing upon comfort and upon health. Nor must we forget to consider the best means of reducing excessive natural light; blinds may be made of any material, which shall sufficiently exclude the light. Much has been written about the choice of colour, but, probably, so far as health is concerned, there is no reason why individual taste should not be consulted on this point.

A passing reference to *the bearing of artificial light upon health* may be made. Artificial light is used for two purposes: for the lighting of the room, and for the lighting of particular objects, such as books or needlework. Under ordinary circumstances, where a room is being used by a few persons engaged in reading or writing, it is altogether unnecessary that it should be brilliantly illuminated. The strong light is required only in particular parts, and for this purpose oil lamps may be most advantageously used, provided with a shade, which directs the light on the object looked at, and preserves the eye from the glare of the lamp itself. We have stated elsewhere that gas does not destroy more air than do the number of candles or lamps which would be required to produce the same light, and we do not, therefore, propose to condemn the use of gas, but simply to limit it to those places where the products of its combustion can be readily removed this may be done by a tube above the gas which passes into some adjoining flue or into the external air. One of the best arrangements is that which surrounds the gas with a circular globe, so as to prevent the flame affecting too much the air of the room; air is admitted through a pipe passing into the room at the point where another tube carrying off the products of combustion pierces the ceiling, while the latter tube is surrounded by one that is larger which also serves to carry off the impure air at the top of the room.

Electric Light.—While we write the electric light is making such rapid strides that we cannot but hope that it will be able shortly to be introduced into even small dwelling-houses, and supplant, for brilliantly illuminating the room, those methods which are necessarily accompanied by the consumption of air. Already, however, we are cautioned that the use of electric light is not unattended by its own risks to health, and we are told that the retina will not bear with safety its hardness. Whatever truth there may be in this statement, experience will, we trust, show us how by the proper use of globes we may overcome this difficulty, and by softening the light render it better fitted for our eyes.

CONCLUSION.

We have now briefly reviewed the conditions which our home should fulfil to enable us to occupy it with the best promise of good health, but it is upon its proper use, upon the order and cleanliness in which it is maintained, that we are equally dependent, if the care with which it has been constructed and supplied is to be turned to a good account.

Necessity for Cleanliness.—We must protest against dirt as not only unnecessary but as even antagonistic to our existence. The late Lord Palmerston has aptly described dirt as "matter in the wrong place," and we may plead that wherever the right place for its existence may be found, it is not in the home which we wish to be healthy. An absolute cleanliness is imperatively demanded as one of the first requirements of health, for we have learnt that dirt is not only concerned in producing results due to the inhalation of so much irritative matter, or due to an interference with the functions of the skin, but that it provides but too readily a growing ground for some of the more serious troubles which beset man.

Upon the regular and systematic cleansing of all parts of the house, be they bed-rooms, sitting-rooms, passages, or offices, be they water-closets, sinks, cisterns, or dustbins, we are as dependent as upon its original construction. By such habits of cleanliness we shall do much to guard against the production of disease in our home, but we must attend to other matters than these if our efforts are to be successful.

The *temperature* of the house must be maintained, its *ventilation* must be ensured and all parts kept habitable, by attention to those details which every good housewife understands and appreciates. Every room should once a day at least, before being occupied, have its windows opened that the external air may circulate freely through it; nor should cupboards or enclosed recesses be forgotten—places which equally require their atmosphere to be freely changed. For the bed-rooms a further care must be given to the beds which have been occupied during the night, and the sheets, the blankets, and the bedding must have an opportunity of freeing themselves by proper exposure to the air from the emanations which they must necessarily have received.

A proper attention to the care of food, and to its preservation under circumstances best fitted to maintain it in a wholesome condition, must also be borne in mind. Our readers will find elsewhere the character and quality of the food which is required for the purpose of health; for us it is alone to consider the circumstances under which it shall be stored. It is essential that it shall be kept in a cool place which is freely ventilated, does not contain the inlet to any drain, is well lighted by direct natural light, and maintained in a state of perfect cleanliness.

The details of *personal hygiene* are equally important, and upon the proper clothing, upon the drying and airing of the linen, as well as upon the cleanliness of the body will health depend. To the regularity of life, to the allotment of proper hours for sleep, for meals, for exercise, and for work, we are also indebted in a high degree. These points have, however, been so fully dealt with by others specially qualified to treat them, that they need no further reference here.

Sickness in the Home.—As yet, we have considered those circumstances which affect our small community as a whole. We have now to think of the time when one member of the household must, for the benefit of the others, be treated exceptionally—when, having developed some malady, his life must be different from those of his house-mates. Speaking generally, we may say that there is even more need for the sick person to have the hygienic condition of his surroundings attended to; thus the choice of his apartment, its lighting, warming, and ventilation are of even more urgent importance than when he was in a state of health. But it may be necessary that the special disease from which it is his misfortune to suffer may require a higher temperature, a moister atmosphere, or a smaller amount of light than that for which we have pleaded; these can alone be regulated by those in whose charge he is. So also the character of his disease may, from its power of communicability to others, have to be borne in mind, and the household so arranged as to guard against the extension of the ailment to others. If he is to remain at home, it is well that all those who are not, by a previous attack, rendered insusceptible to the malady, or whose services are not required, should, during his period of infectiousness, seek a home elsewhere. The best position for a person so affected is in a room which is removed as far as possible from other inhabited parts of the house; usually this will be found on the topmost floor, and if there is convenience for the disposal of excreta in its close proximity, so much the better. His attendant should not associate with the rest of the household more than is necessary, and should, by the wearing of garments which should not be taken to other parts of the house, and by careful ablution, avoid exposing others to the risk of infection.

The details of the management of the sick-room must be thought out and acted upon. Infected linen must not be allowed to mix with other linen of the house; the excreta must be disinfected before being permitted to enter the drains; the most scrupulous cleanliness must be observed, both in the sick person, in his attendant, and in the rooms they occupy; and both must remain in as strict a quarantine as circumstances will permit until a sufficient length of time has elapsed to free the former from infection. Then he may be removed, and it only remains for the infection, which has been already created either in the rooms or garments of both invalid and attendant, to be as effectually destroyed as possible. If death should supervene, a further caution is required. It is not unusual for the deceased to be removed to some other apartment, thus giving opportunity for the infection of another part of the house. This, it need hardly be pointed out, should not be done, but the room should be carefully ventilated, the door kept closed, and every care taken for the prevention of the further extension of disease from this centre.

So also the inmates of our home must, as far as possible, guard against the reception among them of some person who elsewhere may have recently suffered from infectious disease; upon an apprehension of the knowledge that no such disease can occur in their household except it be brought from outside, and upon the exercise of a proper care in this respect will their safety depend.

There is, indeed, but one infectious disease against which a family can absolutely protect itself—we refer to small-pox. By the properly performed vaccination of infants, and by the re-vaccination of those who are approaching adolescence, their immunity from this disease may practically be guaranteed.

We have now referred to, though very briefly, the precautions which must be taken to prevent disease from entering our home, and to the relation of one person to others in time of sickness, but we should be leaving our task unfinished were we not, in conclusion, to emphasise the relation which so strongly exists between a happy and contented mind and the health of the individual. It is impossible for us not to recognise that this contentment is intimately associated with his or her relations with other members of the family. The influence of one mind over another, whether for good or evil, is fully exercised where persons dwell together, and certainly if health is to be found at home, it must not be limited in its application to the body alone.

If our home is to fulfil these higher conditions, it must, by our dealings with each other, provide a resting-place where, removed from the troubles which all must meet in their passage through the world, each shall find the best opportunity for the much-needed repose. But by rest we would not wish to imply that an absence from activity is always the condition which will do the greatest amount of good; it is that within our home each inmate shall find a smaller and a better world than that he meets without. Here should be no rivalry, no struggle; but each, playing his allotted part, should, by the proper combination of thought and work of all, tend to make the whole complete.

Nor must we expect that the tastes and inclinations of all are necessarily identical, although, by the passing of years together, a similarity of thought must, to some extent, pervade the whole house. Each unit of the society will develop tastes in one direction or another, which, giving strength and individuality to his own character, must receive from the other members a proper opportunity for development, and the laws which have to be made for the order of the household must, therefore, be so modelled as to give sufficient scope for all. So we would wish to see encouraged among the younger members the active amusements which befit their age, while in others a taste for literature, for science, or for art, in which many of the busiest minds will find relief, and, while tending to the development of a more cultivated mind, will give to all not only health in the highest sense, but

"A life that leads melodious days."

HEALTH IN INFANCY AND CHILDHOOD.

By W. B. Cheadle, M.D., F.R.C.P.,

Physician to the Hospital for Sick Children, Great Ormond St., and to St. Mary's Hospital.

Capabilities and Progress of the Young Organism—Conditions influencing Development—Food and Feeding—Automatic Action of the Body—Materials Required for Use in the Body—Substitutes for Mother's Milk—Artificial Foods—Alcoholic Stimulants—Air and Light—Exercise and Rest—Clothing—Washing and Bathing—Development—Its Stages and Disorders—General Management of Childish Ailments.

I suppose that there is no subject upon which so many people have an opinion of their own as upon the management of children. Not only parents and nurses, who can speak with the authority of experts, but all who are associated with children entertain views on their moral and physical training; and even amateurs and outsiders are ready to give advice with a facility and confidence too often in inverse proportion to its value.

I suppose also that there is hardly any question upon which opinions and practice are more varied and discordant than upon this. The disturbing elements which interfere with the formation of a rational and unbiassed judgment are unusually numerous and influential, and besides an accurate knowledge of the rudimentary truths of physiology, essential to a correct estimate, is altogether wanting. Such knowledge is of the utmost importance, and should possess the most profound interest for every one, since it supplies the key to the secret of life, in so far as that mystery may be penetrated by human ken. And yet there is, alas! no subject on which people generally are so profoundly ignorant as the structure, mechanism, and working of their own bodies. The study of physiology has not yet become a part of ordinary education; thus the traditions, and superstitions, and prejudices of the nursery, the mistaken canons of wise matrons and doctors of olden days, each or all in varying degree sway and confuse the parent's mind, which is destitute of the accurate data necessary to test their value.

The physical management of children can be reduced to very definite rules by the light of ascertained physiological laws. Such rules, however, although definable within certain limits, are by no means rigid and inelastic. If all bodies were exactly alike, formed in the same mould, with identical machinery, and with the same working force, strength of material, and capacity for development and repair, the thing would be simple enough; but it is not so. Each separate bodily machine is constructed of the same materials, upon the same general plan, and works upon the same general principles; but the quantity and quality of the materials, the exact mode in which they are put together, the relative strength of the several parts, the time for which the machine is constructed to run, the motive force, the rate of running, and the power of self-repair, with a host of minor details, exhibit an infinite variety. And then, again, in children there is still another varying element to be considered, and that is the innate capacity for growth and development. The original constitution, in a word, differs widely in different individuals, so that no hard and fast lines, no strict and exact canons, can be laid down for meeting all points, and ready for application in every instance; they require to be modified and adapted to individual cases.

The main conditions essential to healthy development can, however, be laid broadly down. The grand rules are fully known, and can be definitely stated. What these are, and how they require to be modified under special circumstances, will appear clearly enough, I think, as we examine the physiological needs of the young organism, and the circumstances by which it is surrounded and influenced in the successive stages of early life.

At birth the child enters at once upon new conditions of existence. How great the change is it is difficult for us to realise perhaps, because birth is usually looked upon as the first beginning of life, instead of being regarded as the second stage of a life which had its commencement months before. At that commencement the embryo existed in a state of absolute dependence upon the parent organism—was a part of it—growing from it and living out of it, as the seed grows and lives upon the plant. Locked up securely in the enclosing body of the mother, the embryo is protected from all external injury, and at the same time is kept warm by the maternal heat. Almost every function is performed for it by the parent machinery. There is no labour of breathing, for the respiratory apparatus is not in action, the blood being purified by coming in contact with the maternal stream; the circulation, indeed, is carried on chiefly by the propulsive power of the heart of the embryo, but on a system profoundly modified to adapt it to surrounding conditions and suit its dependence on the circulation of the mother; the digestive apparatus is as idle as the lungs; the mouth has no call to take in food, nor the stomach to digest it, for the child shares the nutrient juices of the mother, ready prepared for absorption and for use.

The excretion of waste, except for some imperfect action of the liver and kidneys, is carried out vicariously, in the same way as the preparation of. fresh material for growth and for repair. The brain has not awakened to perception; the special senses are in abeyance; the action of the nervous system is still wholly reflex and mechanical. So that in this stage nearly every organ of the new body is inert; its functions and power are dormant and untried.

The moment, however, that the connection with the parent is severed, and the young organism, like a ripened seed, is cast off from the parent body to carry on an independent existence, it has to change suddenly into an automaton complete in itself, performing for itself, by its own independent machinery, all the chemical, physical, and vital operations essential to continuance; every organ is abruptly called into action and development, and every function begins to be performed; the lungs are required instantly, to remove carbonic acid and take in oxygen; the mouth has to take in food, the stomach to digest it; the different glands have to prepare the secretions required for these and other purposes; the various organs of excretion must set to work to remove excess and waste; the circulating apparatus has to drive the blood without delay into new and previously impervious channels; and the animal heat must be kept up by combustion of food.

The due performance of all these functions has become essential to life; the apparatus by which they have to be carried out is new to the work; hitches, and difficulties, and irregularities are too liable to arise, and their occurrence may put a sudden stop to the complicated machinery.

The infant, on its advent into a separate existence, then, requires especial care and help in many points. Certain of the functions of the body require assistance for a time, until they reach strength and perfection enough to work alone. The power of making heat must be aided at first, for the child has to keep up a temperature of 98°·6, in the medium of outer air at 50° or 60°, into which it has been abruptly plunged. Its delicate frame must be guarded from all rough usage. Its lungs, newly inflated and unaccustomed to chill air, must have a pure warm atmosphere to inhale. The stomach, hitherto innocent of food, must be supplied delicately and sparingly with the most digestible nutriment, which shall also comprise every essential element of food. Thus, the fragile life, gently nurtured and aided at first, until its powers develop, gradually becomes fitted for a more completely independent existence as it advances, stage by stage, from infancy through childhood to adolescence.

Conditions which Influence Development.—The conditions which determine the structure and fashion of the young body during the period of development, and the degree of strength and perfection to which it attains, are numerous and complex. Amongst them are food, climate, moral influences, accidental injury or disease—all these accelerate or retard its development in varying degrees. Yet the chief, perhaps, is the original constitution with which the embryo is endowed at birth. It is the result of influences which have been at work for generations—moulding the form and tendencies of progenitors on each parent's side in a thousand different subtle ways; and these combined influences, increasing or lessening peculiarities of structure or character, according as they are similar or antagonistic, determine the possibilities of the child's career.

There is, then, an infinite variety in the original constitution of individuals. In some the machine is constructed, as it were, to run easily and well, under favourable circumstances, for seventy to one hundred years—the full term of existence. It is endowed with rich power of development; its component parts are made, with the daily repairs that go on, to endure for that time; and it has initial force, as a clock wound up has force, to keep in motion for a given space. But every being is not fashioned so perfectly at the outset. Some are feeble, ill-constructed, and rickety to begin with; and instead of being endowed with a capacity to keep going for seventy or a hundred years, will run but for a portion of the time; perhaps only for a few years, or months, or even hours. Nay, the original vice of constitution may be so extreme that the embryo being perishes before birth.

The peculiarities and tendencies of original constitution can be largely modified by surrounding conditions; merits and defects, each lessened or increased; development, in one direction or the other, fostered, diverted, or repressed. Under favourable influences the feeble body of faulty construction may be nurtured into some degree of vigour and stability; the perfect and robust one flourish and expand into the full glory of strength and beauty of form; while, under adverse circumstances, the first will dwindle and die, the latter degenerate and grow stunted and deformed.

The broad general conditions which favour the development of the young organism to the highest perfection of which its original construction renders it capable are briefly these :—

I. The growing body must be supplied with ample food, and this food must contain all necessary ingredients, in the form in which the body can best make use of them. Just as a plant requires not only a fertile soil, but one adapted to its special habit and character, to bring it to full beauty and luxuriance, so does the child require suitable food to enable it to grow to its highest strength and perfection of form.

II. The second thing necessary for perfect development is pure fresh air, containing abundant oxygen for the vital chemical changes which go on in the body, and untainted by foul gases, or floating injurious germs or atoms.

III. The third great essential is light. We are children of the sun—the central source of energy from which directly or indirectly is derived the working force which drives the animal machinery. Light is as essential to the health of the higher animals as it is to that of the higher plants.

IV. Another necessary aid to healthy growth is clothing, to preserve the heat of the body at the natural standard, and to protect it against sudden changes of temperature.

V. A further important condition influencing perfect development is exercise: not mere exercise of the muscles of the limbs and frame, but of all vital organs, such as the lungs, heart, and brain. These require to be brought into full play from time to time, in order to ensure their due growth, and that they may be brought to work easily and effectively. And after action, rest.

VI. The last important condition of healthful development is complete cleanliness of body and clothing, so that the skin may be kept in vigorous and ready action, and all noxious excretions and waste material removed from the surface as they accumulate and decay.

Food and Feeding.

The Human Body an Automaton.—That most delicate, complex, and perfect automaton, the human body, differs, like other living organisms, from the ingenious automata constructed by man, in these great points, amongst the rest, that it is not only self-acting but self-repairing and self-feeding.

The daily wear and tear of work in a machine involves waste and destruction of the materials of which it is composed. It involves, also, the consumption of the materials which generate the force or energy by which it is kept in motion. In a steam-engine, for example, the furnace and boiler wear out by heat and chemical action. The levers, and wheels, and joints are worn away by friction, while the coal and water used to make the motive power of steam are rapidly consumed. The worn boiler and furnace, and cranks and wheels, have to be repaired not by the action of the machine itself, but by the hand of man. The used-up coal and water are replaced not by the automatic action of the machine, but by the external agency of the stoker. In the human body it is different. The repair of daily wear, the renewal of the supply of fuel, is effected by the machine itself.

Yet, the animal machinery and that of the steam-engine have a close analogy to each other in many points. The force which moves the steam-engine is generated by the burning of the combustible material, coal, or coke, or wood, and by its conversion, by union with the oxygen of the air drawn into the furnace, into various products, chiefly carbonic acid and water. The heat thus produced vaporises the water of the boiler into steam, which by its expansive force sets the machinery in motion.

The heat which keeps the human body at the necessary temperature, the force which moves the limbs, which pumps the blood through the vessels, and drives it to every quarter of the structure, and which effects, indeed, every operation of the mind, is derived in exactly the same way—from the combustion of fuel, viz., food, and its conversion, through chemical combination with the oxygen of the air drawn into the body by the lungs, into carbonic acid and water, just as the coal is converted in the furnace of the steam-engine.

The intermediate link between the force set free as heat by combustion, and its appearance as motor force or nerve force, we do not know. But of the conversion of the one into the other there seems to be ample proof.

Then, again, as with the steam-engine, so with the body, the various parts undergo constant waste in daily working, and the materials of the tissues, more fragile and unstable than the iron, and brass, and copper of the engine, wear much more speedily and continuously. And thus old materials are unceasingly being removed, and as constantly being replaced by new materials, in unremitting self-repair. Automatic renewal of the materials of which the body is constructed is a special and peculiar property of living matter, which cannot be imitated by the handiwork of man. The steam-engine wears away unless worn parts are replaced by new ones through external agency. The contrast might be carried further: the necessary materials are gathered by the animal machine of its own action. It is only in helpless babyhood that nurse and mother act as stokers to the imperfect organism, and spoon food into the furnace of our bodies as coals are shovelled into the furnace of a steam-engine.

But more than this, not only does the body by its own unassisted action provide fuel and material for the repair of tissues, so that it does not suffer loss, but it actually for a time increases in size and in perfection—it grows. For years and years, during its early existence, it undergoes spontaneous development and improvement. It waxes larger and more complete in all its parts, and all its powers. As time goes on, after it has attained maturity, it does indeed lose ground; but although decay commences, repair goes on even to the last. The decline is gradual, checked always by partial restoration to the end, when, loss overbalancing gain, the machine stops, and death results.

The body requires, then, a constant supply of materials for various essential purposes. In a full-grown person the chief of these are the repair of structures, the furnishing of secretions requisite for certain vital functions, as the juices which effect digestion, for example, and also the supplying of fuel to be burned for the generation of heat and force. In children materials are required for all these purposes too, but there is in their case one grand requirement in addition—viz., the need of what may be called *building materials*, for the making of the new tissues of the growing structure. *So that while a mature adult can thrive on a limited assortment of food, provided that it contains enough combustible matter for the supply of energy, and enough of other materials for the secretions and repair of waste and loss, the child requires a larger and more varied assortment, containing in addition certain special ingredients necessary for the original structure of new parts.* Some of these, when once completed—as, for example, the mineral portion of the bones and the teeth—are permanent; they require little or no repair.

Materials Required for Use in the Body.—The nature of the materials required for all these various ends, and the degree in which they are found in different kinds of food, is a question of the greatest interest and importance. If the materials of which the body is composed, be reduced to the simplest elements by chemical analysis, they are found to consist of some seventeen constituents, of which carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, chlorine, sodium, potassium, calcium, magnesium, and iron, are the most important. These simple elements do not, however, exist in the body *as such*, isolated and alone, but they are combined together in definite proportions, forming compound substances. Thus carbon, and hydrogen, and oxygen, combined in certain proportions, exist as fat; nitrogen and carbon with hydrogen and oxygen make muscle; and so on. Further, the body has no power to form these compounds for itself. It cannot take so much carbon separately and use it for forming fat, or so much nitrogen and combine it with other ingredients to form muscle. These rude chemical elements must first be joined together by other agents, and formed into the compounds required, before the body can make use of them. Some of these, as certain salts, and water, are inorganic compounds, formed by ordinary chemical agencies; but others—and the most important—are *organic*, formed only by the special power of some living agent.

The indispensable servants who do this office for us are plants, who prepare raw materials for the use of the animal world. Man appropriates the composite substances formed by plants out of simple elements for the structure and repair of his body. Whether we eat grain, or roots, or fruits, or fish, flesh, or fowl, either directly or indirectly the source of supply is derived from vegetables. Plants are the agents in the first instance. If we eat beef, the ox from which it is taken has elaborated his flesh from grass and roots. If we eat the flesh of an animal which feeds on others, such as an insectivorous bird, or a fish, the flies and gnats and worms on which it has fattened have derived their sustenance from the nectar of flowers or the juices of fruits or leaves. And thus the chain of life runs down from animal to vegetable organisms, and thence to the inorganic world. Plants prepare for animals the compounds on which they live; stand between them and crude inorganic substances.

Thus we are but shoddy creatures after all, made up of old materials worked up again—materials which have been used for the like purpose in plants, or in both plants and animals, many and many a time before.

The compound substances thus prepared in the first instance by plants, and passed on for use in animal bodies, and by them from one set to another, are grouped in distinct classes, according to the elements they contain, and the uses which they serve.

The type food is milk, which contains all classes of ingredients, and supplies everything necessary for life and growth. The first and most notable of these is what is styled the nitrogenous class, distinguished by the presence of the element nitrogen.

Albumen, of which white of egg is a pure example, is the most important of this class, which contains other similar bodies, such as the curd of milk, the gluten of wheat, the fibrine of blood and muscle, etc. The name of albuminates is often given to this group of allied substances. These albuminates all contain fifteen to sixteen per cent. of nitrogen, and from a nutritive point of view are of the highest value. Nitrogenous bodies of inferior value are gelatine and chondrine, found in tendon, bone, and cartilage, the former furnishing the jelly which forms the "stock" or basis of soups and extracts of meat.

The nitrogenous elements are found in both animal and vegetable foods, but are much the most plentiful in the former. The flesh of animals, or meat, for instance, contains several of these nitrogenous bodies, as albumen, fibrine, gelatine, and is a nitrogenous food of the highest value, since it is found by experiment that life is sustained better on a mixture of the various forms than on any one alone.

The nitrogenous materials are the most important of all the elements of food. Strangely enough, as it may seem to us, although we are immersed overhead in an atmosphere four-fifths of which consists of nitrogen, yet our bodies have not the power of absorbing one single atom of this vital material in its simple form from the surrounding air. The supply has to be obtained entirely from food; and its intrinsic importance will be seen from the fact that, not only have the muscles to be made from it, and repaired with it, almost exclusively, but that it forms an essential ingredient of brain and nerves also, of most secretions, and of protoplasm, the active agent of life and growth and function in every cell. Nitrogenous matter, then, in its best form, that of albuminates, is the most important of all materials required by the growing body; for no operation of existence or of development can go on without it. It is present in large quantity in the type food milk, as casein, or curd. If the supply of nitrogen is cut off from the body all its powers languish; after a time they utterly fail, and death results.

Nitrogenous food is used in some degree, also, for the production of heat and energy, perhaps also for the manufacture of fat, but these offices are comparatively unimportant, and subsidiary to the rest.

The second group of elements found in food is that of the *hydrocarbons*, or *fats*, which exist in both animal and vegetable products. One of the chief purposes served by fat is to supply the body with heat, and with force in all its forms. Fat is burnt up in the body, just as oil in a lamp or tallow in a candle. By it the Esquimaux, the seal, and the whale, keep up their vital heat amid the fierce cold of an Arctic winter. Fat also serves other good purposes; it enters largely into the composition of all nervous structures, and of most cells, especially of those of the marrow of bone, which are the active agents in building it. Further, it helps to form the adipose, or fatty tissue, which fills up interstices, pads the irregularities of the frame, and serves as a store of fuel laid by for future use. Fat exists in large quantity in milk, as cream or butter, and *is an ingredient of food absolutely essential to children for purposes of growth and development, second only in importance to the albuminates.*

The *third group* of elements of food is that of the carbo-hydrates, or starches and sugars, found almost entirely in vegetable products. Their chief office appears to be to supply fuel—light fuel, burnt up more quickly, and of less heat and force-producing power than the concentrated combustible fat. The carbo-hydrates do not enter into the structure of any part directly, but the excess not used at the time appears to be converted into fat, and stored up in reserve. They are represented in milk by lactine, or sugar of milk, and it is worthy of note that in this type food, carbo-hydrate, in the form of *starch,* is entirely wanting.

The *last group* of elements is that of inorganic substances—iron, phosphorus, the various salts of lime, potash, and soda, and water. Iron is one of the vital ingredients of red blood-cells, phosphorus of nerve and brain, while lime is largely used in the permanent structure of bones and teeth, giving them hardness and stability.

These inorganic materials are found in milk, and exist probably in sufficient abundance in all foods. Water forms four-fifths of the body; it is essential to the fluidity of the blood and of all secretions; and it is the carrier of nourishment to the tissues, and the agent for removing waste from them. Water also exists in the type food, milk, of which it forms upwards of eighty per cent.* This last group of mineral elements, being largely used in making new structures, is one of immense importance in the food of children.

Requisite Proportions of each Element of Food.—Such being the materials of food essential to the nutrition of the body, in what quantity, and in what proportion, must these various ingredients be given to the child at various stages of its growth? Nature has supplied the key to this question in the form of the standard, or type food—milk. Like an egg, out of which alone the body of the chick is formed complete in flesh, and bone, and every vital organ and fluid, so milk contains every element of food necessary to the perfect formation and nourishment of the animal body. It contains the life-giving nitrogenous element in the form of curd, or casein; the hydro-carbon fat in the form of butter; the carbo-hydrate element in the form of sugar of milk, or lactine; and water and mineral elements or salts.

But there is a furthur curious quality which milk clearly possesses. It is found necessary in the case of adults that every diet should contain a certain proportion of fresh vegetable food, in order to prevent the occurrence of scurvy, which certainly follows if this element be omitted. The virtue is presumed to lie in certain organic acids which are found in fresh vegetables in combination with potash. Yet milk-fed children, who get no fresh vegetables, never suffer from scurvy; so that, in addition to the other essential elements, milk must also contain in some form the anti-scorbutic element furnished in ordinary diet by fresh vegetables.

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* Some of the less important members of each group have been omitted from this brief summary of the elements of food for the sake of simplicity and conciseness.

TABLE I.

Showing proportion of different ingredients in human milk, fresh cow's milk, and condensed milk. (*Kehrer, New Syd. Soc., Vol. LXXI.*, 1877, *pp.* 364 *and* 372).

	Gorup-Besanez.		Werner.
	Human Milk.	Cow's Milk (Fresh).	Condensed Milk.
Nitrogenous matter—albumen and casein (curd)	3·924	5·404	24·2 to 28·1
Fatty element (cream)	2·666	4·305	12 to 13·6
Carbo-hydrate element (sugar of milk)	4·364	4·037	14 to 18
Salts	0·138	0·548	2·1 to 2·6
Water	88·908	88·705	18·8 to 22·4
Cane sugar	—	—	24 to 30
	100	100	100

If, then, the mother of a new-born child be sound and healthy, has a sufficient supply of milk, will take the trouble to nurse her baby and to live wisely and carefully for its sake, she can give it every element of food it requires in the best possible form. An infant suckled by its mother seldom gives much trouble; it is usually comfortable and contented. In rare instances only does the milk of a healthy mother, living properly, devoting herself to this duty to her child, disagree with it.

I have twice seen this intolerance of the mother's milk so great that it was absolutely necessary to wean the child and place it on cow's milk; and, curiously enough, this was digested without difficulty. Such cases, however, are extremely rare, and must be considered as exceptions. In ninety-nine cases out of a hundred it agrees perfectly, and the surest means of keeping a child in health, as well as of escaping all the troubles and anxieties which are liable to beset the first few months of its life, is for the mother to suckle her infant—wholly if she can; if not entirely, then, at any rate, partially.

Rules for the Feeding and Management of a Child at the Breast.—A few brief rules will be sufficient for guidance in the management of a child brought up at the breast. It should be fed at regular intervals; for the first three months, every two hours during the day; every three hours during the night, if it sleeps well. After the first three months a strong child, which can take freely and sleeps well, may go three hours during the day and four hours at night.

The quantity taken each time of feeding by a child at the breast during the first month or two is probably about two ounces—*i.e.*, the amount yielded by one breast. After a time it takes more, and in the end exhausts both breasts—four ounces or more. A good rough rule is to let the child remain until it shows signs of having had enough.*

The whole quantity required by a child under three months would accordingly be twenty ounces at least, and later, when it is older than three months, about thirty ounces or more; but the best test to find out whether the infant has food enough or not, lies in its condition—whether it seems satisfied, sleeps well between times, is merry, content, and thriving.

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* The breast of a good nurse should yield every two hours at least fifty to sixty grammes, or about two ounces (Lampériere, quoted by Kehrer, New Syd. Soc., Vol. LXXI., 1877, p. 360.)

When the child has finished taking the breast, its mouth should be washed, so as to remove all adherent milk, which would become sour, and thus taint the next draught. The nipples should be carefully sponged, and then dipped for a few moments in brandy; in this way the skin is hardened, and soreness is prevented, and also any decomposition of milk adhering to them, which might turn sour and disagree with the infant at the next suckling.

The mother who would do the best she can for her child must be content to lead a quiet, wholesome, and regular life. She must give up all exciting amusements and occupations which only take her from home, and lead to her being absent at the child's feeding time, or if not absent at least late for it. Extreme regularity and punctuality in nursing are of the greatest importance. If the child be left too long without food, it takes it too greedily and quickly when it does get it, becomes flatulent, uncomfortable, vomits perhaps, and then craves for food again before the due time comes round; digestion is disturbed, remains out of order, and thus endless little troubles arise from desultory irregular nursing. Then again the nursing mother must be content to live on a simple diet—plain soups, or broths, with meat, fish, fowl, or game, and a light milk pudding — *i.e.*, avoiding all richly made dishes, ascescent fruits, or wines. She may take a good, plain, ordinary diet, with a small quantity of wine or beer if she be accustomed to take it, and a rather larger supply of fluids, in the form of milk or cocoa or gruel, or even water, than she would take at other times.

Fresh air and moderate exercise daily are essential to full health, and, therefore, are essential to the nursing woman; indeed, the grand rules for her guidance may be summed up in this: let her lead a healthy, natural life, and all will go well with her and her child.

But supposing the mother has too small a supply of milk to support her child entirely, or from any other cause—such as other occupations of an imperative kind—or from not being strong enough to bear the full strain—is unable to nourish it wholly from the breast, what should be done? Many women, fretted by the restraints which nursing involves, or troubled by a sensation of faintness and languor at first, are too ready to make any deficiency in the supply of the breast milk an excuse for weaning the child altogether. In this they are supported by a popular prejudice against hand feeding and suckling together. A superstition still exists amongst nurses and matrons that cow's milk and mother's milk do not agree, as if they quarrelled in some curious way within the child's body, and fought it out there to its great discomfort and damage; but this is a pure fallacy. The cow's milk may disagree with the baby's stomach, but not the mother's milk. All the child can get of the latter is pure gain—half a loaf is better than no bread. The fact of the child having so much of the best and most nourishing food it *can* have, will in no possible way lessen or interfere with its power of digesting cow's milk. It may be that the child has not digestive power equal to dealing with cow's milk, but that is all the more reason why it should have as much mother's milk as possible, which it *can* digest. And for the rest, if it cannot digest cow's milk duly diluted, other food of lighter kind must be given—of this hereafter. It cannot be stated too strongly, however, that a healthy mother should suckle her child, even if only able to give it a very inadequate supply. It is better for her—she will, as a rule, develop more vigorous life—better for the child also.

When the bottle has to be resorted to in addition to the breast, the best way is to give it at equi-distant intervals of time; if twice in the twenty-four hours, then at intervals of twelve hours; if four times, every six hours, *i.e.*, every third time of feeding; or if necessary, alternately. This plan is far preferable to that of giving the bottle at night, and the breast only in the day-time. The breast milk accumulates during the night, and the child gets a sufficiency or an excess the first meal in the morning—during the day a deficiency.

If the mother be really too feeble or delicate to bear the strain of nursing; or is constitutionally tainted with scrofula, consumption, or other serious disease; or if her milk fails entirely; then there is no choice: the child must be fed otherwise, and the anxious question arises, "On what shall it be brought up?" Upon the right decision of this depends the health, perhaps the life, of the infant, and the ease and comfort of the mother and nurse.

Substitutes for the Mother's Milk.—There can be no doubt about the best thing to be done if it is feasible: the best substitute for the mother's milk is the milk of some other woman. A good wet nurse usually saves all further trouble; the baby is transferred to her breast, and all goes well. The points to be observed in selecting the foster-mother are that her child should be about the same age as the one she is to suckle, that she should have an ample supply of milk, and be a fairly robust person, free from constitutional disease. For the satisfactory determination of these qualities she should be examined by competent medical authority. Whether the constitution of the child thus suckled is really influenced by that of the foster-mother is a moot point. We do not know that disease can be communicated through the nurse's milk; but it may be by contact with the nurse, and it behoves us to be cautious.

The expedient of a wet nurse, however, cannot always be adopted. It may not be possible to find a satisfactory one at the moment, the expense may be too great for the parents' means, or the addition to the establishment too inconvenient, and the child has to be fed by hand. If so, the best substitute for human milk is asses' milk, which, as may be seen from the table, closely resembles it in composition.* It is even lighter, of a fine curd, and easily digested. But here again the difficulty of expense and supply come in. It is not always possible to obtain asses' milk—at least out of London, where there are regular establishments for its supply, and it is a costly food even there. Some parents, moreover, have an uncomfortable belief that their child's nature may be unfavourably influenced by asinine nutriment. Mulish qualities have never been traced to this source any more than a bovine nature to a diet of cow's milk, although I have heard them gravely attributed to it.

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* It has been suggested that certain diseases of cattle, such as a form of tuberculosis of the lung or consumption, and foot-and-mouth disease, are communicated through this channel. It will be sufficient to state here that, so far, no satisfactory evidence has been adduced in support of this theory of infection with the constitutional diseases of animals by means of milk.

TABLE II.

Showing proportion of different ingredients in various kinds of milk (Payen's analysis). The proportions in human and cow's milk differ slightly from the later analysis of Gorup, Besanez given on a previous page.

	Human.	Cow's.	Asses'.	Goat's.
Nitrogenous matter (curd) and insoluble salts . .	3·35	4·55	1·70	4·50
Fat (cream)	3·34	3·70	1·40	4·10
Lactine (sugar of milk) and soluble salts . . .	3·77	5·35	6·40	5·80
Water	89·54	86·40	90·50	85·60
	100	100	100	100

Usually, however, from one cause or another, this second-best alternative to the mother's breast proves to be out of the question. It is necessary, then, to fall back on cow's milk—either fresh, or the preserved Swiss or condensed milk—or goat's milk.

Goat's milk is often procurable, but it is too rich in solids for young children, although it is excellent food for those old enough to have a digestive power equal to dealing with it. Most commonly it is found easiest to use cow's milk in some form; generally fresh cow's milk diluted with water. At first one part of milk to three parts of water is given, with the addition of a little sugar. A reference to the table of analysis of milk at page 639 will show that cow's milk, diluted to this extent, will be much weaker in every constituent than human milk; it would only contain 1·351 nitrogenous matter, 1·076 fat, 1·009 sugar of milk, *i.e.*, resembling asses' milk (Table II., Payen's), except in the amount of sugar of milk, of which it contains a much smaller proportion; *i.e.*, only one-sixth as much; this deficiency, however, is made up by the addition of white sugar.

It would seem at first sight that cow's milk thus prepared ought to answer the purpose, but unfortunately in actual practice it is too often found unsatisfactory. Sometimes the child can digest it, and all goes well; frequently, however, the diluted cow's milk sets up colic, vomiting, diarrhœa. The reason that cow's milk is less easy to digest than human milk does not lie in the fact that the former contains more solids—especially curd—but in the peculiarly solid character of the curd itself. The mere addition of water does not alter this.

This distinctive character of the curd of cow's milk, and of goat's and sheep's milk likewise—as compared with that of human or asses' milk—is shown by the effect of digestive fluid upon it. The curd of human milk is thrown down in fine flocculent masses, readily dissolved by additional fluid; while the curd of cow's milk is cast down in great masses, and is not dissolved on the addition of more fluid.

Further, if human milk and cow's milk be placed in two glasses, side by side, with a small quantity of gastric juice, and kept at a temperature of 100°—*i.e.*, artificially digested—the solid curd of cow's milk takes a very much longer time to dissolve than the light flocculi of human milk. Any one who is curious to do so may satisfy himself as to the difference in coagulation by a more simple experiment still. Add a little rennet or vinegar to cow's milk, and also to a sample of human milk. In the latter the acid produces little appreciable change, it remains almost uniformly liquid. In the former it leads to the immediate formation of large masses of coagulated curd. Goat's milk and ewe's milk behave in the same way as cow's milk, while mare's resembles asses' milk and human milk in this respect. The chief secret of the difficulty with which cow's milk is digested by infants, then, is in this massiveness and insolubility of the curd.

The fault may, however, be largely modified and the curd rendered more flocculent by certain expedients. The fact that boiled milk agrees better with children liable to diarrhœa has long been known; but the explanation has not, I think, been given. It is this: the process of boiling has the effect of making the curd coagulate in much smaller masses. A repetition of the previous experiment will show this change. Rennet or vinegar added to cow's milk which has been boiled produces no longer the massive curd characteristic of fresh cow's milk, but much smaller and lighter coagula—an approach to the flocculi of human milk, although somewhat larger and coarser than these.

Condensed milk, again, if sufficiently diluted, is far more easily digested by infants than fresh cow's milk. The explanation of this lies in the fact that the process alters the coagulability of the casein, and it forms light flocculent masses. These are coarser than those of human or asses' milk, finer a little than those of boiled milk, and far more so than unboiled milk; so that in degree of digestibility the three varieties would be—1, condensed milk; 2, boiled milk; 3, fresh milk.

Rules for giving Cow's Milk.—If, then, it should be decided to use cow's milk, it should be tried cautiously at first, and it must be given up at once if it does not fully agree. It is best always to give it boiled. There is another advantage in using boiled milk in addition to its greater digestibility—viz., the protection afforded thereby against infection. It has been proved in a very striking and unquestionable manner during the last ten years that the special poisons of typhoid fever, scarlet fever, and diphtheria, are sometimes conveyed into the bodies of the sufferers with the milk they drink. Now, contagious matter appears to be destroyed by heat at the boiling point,* and there is evidence that in the case of the Marylebone epidemic of typhoid of some years ago, which was traced to milk infection, those households escaped in which the milk was boiled. All nursery milk should, for this reason then, be boiled the moment it is received at the house, and also in order to stop at once any process of fermentation set up, and consequent souring. The objection to boiled milk, that it causes constipation, is of doubtful validity. It is, no doubt, less laxative, because more perfectly digested; but in any case this tendency can be relieved by the addition for a time of carbonate of magnesia in any quantity which may be found necessary.

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* See Dr. J. A. Russell, Quain's "Dict. of Medicine," p. 398.

The milk should, if possible, be obtained from one cow, so that its quality may be uniform; and it should be ascertained that the animal is fed upon dry pasture grass, hay, and cake or corn; not on turnips, rank grass, or clover, which appear to render the milk acid and liable to disagree.

To the boiled milk water should be added in the proportion of 3 parts to 1—making the mixture, therefore, one quarter of the strength of pure milk. The water should also be boiled, thus reducing its hardness, and destroying the activity of any contagion or impurities which it may contain—a very essential safeguard, especially in towns, and in country places also, unless the water supply be absolutely above suspicion. A tablespoonful of lime-water, or a pinch of carbonate of soda, may be added to render the casein more digestible, and neutralise any possible commencing sourness.

The diluted cow's milk will be weaker than mother's milk in every ingredient; the exact proportion of each has been given above in speaking of feeding as a supplement to the breast. The deficiency, it will be seen, is greatest in lactine, and to remedy this sugar must be added in the proportion in which it is wanting—viz., 3·355 per cent., or ·671 oz., to 20 oz.—or roughly, a little more than half an ounce, or one small tablespoonful, to the pint, or a large teaspoonful to the bottle of six ounces. Lactine or sugar of milk would naturally seem the proper kind to use, as being the identical form found in milk. There are, however, objections to it practically; first, it is expensive; secondly, it does not dissolve so easily and is not so sweet to the taste as ordinary cane sugar; and, lastly, it ferments and forms lactic acid more readily. So that, on the whole, fine white sugar is to be preferred. If the milk agrees, the strength may be gradually increased, so that at two months old it is 1 part to 3, at three months 1 in 2, until at six months the child is able to take undiluted milk.

The quantity of cow's milk required varies according to the size and vigour of the child; but an infant of average development should take for the first month about 1 pint, in the second month $1\frac{1}{4}$ pints, the third month $1\frac{1}{2}$ pints, the fourth month and after $1\frac{3}{4}$ pints to 2 pints. In place of fresh cow's milk condensed milk may be used; for delicate children, with feeble digestive powers, it is to be preferred.

The advantages of condensed milk are that it keeps perfectly—that it is convenient—always at hand—and that the curd is more digestible (as previously explained) than that of fresh cow's milk.

The objections to it are that it contains a large excess of cane sugar,* added for the purpose of preserving it; and then, if the milk should commence to ferment, lactic acid is formed in greater quantity, and causes irritation of the stomach. The excess of sugar in condensed milk also tends to make infants fed upon it wax fat out of all proportion.

The mistake constantly made in feeding young infants on condensed milk is to make it too strong. The directions on the label state that for infants 7 to 14 parts of water are to be added. But this is far too strong for a baby at birth, or even of a month or two old, at first. For the first few weeks one teaspoonful to forty teaspoonfuls of water is enough to begin with, but the strength must be increased as the child is found to bear it. With older children, up to three or four months even, it is wise not to *begin* with it more than 1 in 30, increasing the proportion gradually and carefully until the full strength of 1 in 10 to 1 in 7 is reached at about six months old.

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* Condensed milk contains (according to the analysis of Werner and Kofler) 38 to 48 per cent. of sugar. When diluted with 5 parts water to bring it to the strength of cow's milk, it will contain about 8 to 9 per cent., or twice as much as ordinary cow's milk. With regard to other constituents, it would contain rather less nitrogenous matter than cow's milk—viz., 4 to 4·6 as compared with 5·404; of fat, however, decidedly less—2 to 2·2 as compared with 4·305.

Artificial Foods.—Some children appear to be unable to digest diluted cow's milk of a strength sufficient to afford enough nourishment to support life. They are sick, bringing up large clots of curd—pass undigested curd from the bowels—become flatulent, and are constantly crying, with legs drawn up from the griping pains of colic and diarrhœa. If nothing be done to arrest it, the vomiting and purging increase, and this may soon have a serious and even fatal issue; the child becomes pallid, flabby, wrinkled, wastes away to a mere skeleton, and if no change be made dies rapidly of inanition.

The only safe plan with children who exhibit intolerance of diluted cow's milk—either boiled or condensed—is to use some other food as a basis, to which the milk may be added in much more minute quantity at first than is usually employed—gradually increased as the power of digesting it improves. Perhaps the best material for this purpose is the bread jelly, prepared according to Dr. Churchill's formula. A thick slice of bread made of seconds flour, as containing more of the nitrogenous element than the best white flour, and three days old, so as to be well dried and sweet, is placed in a basin of cold water, and allowed to soak for eight hours. All the water is then thoroughly squeezed out of it. The object of the first soaking and removal of the original water is to clear away the lactic acid formed in fermentation, and all other irritant matters. The pulp is then placed in fresh water and gently boiled for half an hour. The object of the boiling is to thoroughly soften and break up the starch corpuscles, which are insoluble in the digestive fluids of young children. This water is strained away, and the remaining pulp rubbed through a fine hair sieve. It is then allowed to grow cold, when it should form a fine, smooth, jelly-like mass. Enough of this is then mixed with warm water to make food of the consistence of thin cream, so as to pass readily through the bottle.

Boiled milk is added—at first only one to two teaspoonfuls to the half bottle—and a little white sugar. The milk is slightly increased every few days, as the child is found able to digest it, and then it is gradually advanced at six or eight months old to pure milk, thickened with the jelly.

The bread pulp should be freshly prepared night and morning, for it will not keep long. Nurses and mothers raise objection to it now and again, on the ground of the trouble involved in making it. But this is well spent, for when properly made it forms the blandest of all foods for infants on first weaning. Another excellent substitute for milk for a young infant is whey, with three teaspoonfuls of boiled milk and one small teaspoonful of cream added to each half bottle. The amount of milk is gradually increased. Similarly, barley-water may be used, with the addition of cream, to tide over a difficulty, and milk may be gradually added afterwards.

Other substitutes for milk largely used are the farinaceous foods prepared on

Liebig's principle of partial malting, and thus converting the starch of flour, which an infant has small power of digesting, into dextrine, an incipient sugar, which the child's stomach is better able to deal with. *Alone, however, such food is insufficient for perfect nutrition, partly from the deficiency in fat and nitrogenous matter, and partly from lack of some animal element.* If milk be added, the casein in this, together with the gluten of the flour, supply the essential nitrogenous element in sufficient quantity. Fat, the important element, however, is still deficient —the only source being the cream contained in the milk. This is, of course, remedied in proportion as a larger amount of milk is given, or by adding cream.

This malted food agrees perfectly in most cases with children over three months, and those fed upon it, *with milk in addition*, are usually firm-fleshed, lively, and vigorous. It is, however, often laxative in effect, and does not always agree with young infants.

Other foods in common use are prepared from wheaten meal, the starch of which, as in Liebig's food, has been partially converted into dextrine and sugar, with the addition of desiccated milk. The fault of such preparations is that, like the preceding, they contain a large excess of the carbohydrate elements—starch, dextrine, and sugar, and a deficiency of the nitrogenous element or albuminates, and of fat. From the analyses given below* it will be seen that, as prepared for use, this milk food contains little more than one-third as much nitrogenous matter, and only one-fifth as much fat, as human milk. The result of feeding children on such food alone is, according to my experience, in exact accordance with what might be inferred from its composition. It usually agrees with them, and they are free from sickness, flatulence, or food diarrhœa; but they are flabby, soft-fleshed, pallid; liable to bronchial and intestinal catarrhs; have feeble resisting power against acute disease; are deficient in vitality and vigour, for lack of nitrogen. Moreover, from deficiency of fat and salts for bone-making, and albumen for muscles, they are constantly rickety, develop imperfect teeth, and get them badly; and in one instance within my knowledge a child fed on this food alone developed actual scurvy of severe degree.

These so-called milk foods, in a word, although of good digestible materials, are, in spite of the milk they are reputed to contain, too poor in animal matter, especially albuminates and fat, to supply fully the ingredients essential to vital energy and a perfect development of the bodily structure.

* Jacobsen's analysis of Nestlé's food (Kehrer, op. cit.) gives—

Nitrogenous matter	15 per cent.
Fat	5 ,,
Dextrine and starch	30 ,,
Cane sugar and sugar of milk	40 ,,

This, when mixed with 10 parts of water to make food pass through the bottle, would yield—

Nitrogenous matter	1·36 per cent.	
Fat	·45 ,,	
Starch and dextrine	2·7 ,,	Carbonaceous = 6·3.
Sugar	3·6 ,,	

Compared with milk (human)—

Nitrogenous matter	3·924 per cent.
Fat	2·666 ,,
Starch	0 ,,
Sugar	4·364 ,,

The grand defect, then, of all these artificial foods is that they are vegetable, and consist mainly of starch. As a rule no farinaceous food of any kind should be given to a child under six months old, except as a temporary expedient, or as a basis to which to add milk or cream. Nature gives conclusive evidence against it. *The natural food of the infant—milk—is animal, and contains no starch; and yet the common substitute for it is a food almost entirely composed of starch.* Moreover, it seems to be a physiological fact that for the first few months of life, young animals, and human babies amongst them, have little or no power of digesting starch. It is not an ingredient of their proper food, and they are not endued with the means of dealing with it. It is true that in the best of the artificial foods the starch is partly converted into dextrine and sugar, which they can make use of, yet the grave fault of inadequate supply of the vital albuminate and fat remains.

In fine, no artificial farinaceous food should be trusted, unless it has animal albuminate and fat added to it in the form of milk or cream, or other animal food, such as meat or beef-tea, be given in addition.

Worse even than the patent foods are the household farinaceous preparations often made use of.

Arrowroot is almost pure starch, and the prepared corn-flour is little more—maize robbed of its most nutritious ingredients. These substances are largely given, especially by the poor, because they make a smooth gelatinous fluid, which looks the very ideal of a light digestible nourishment. But children fed on this alone grow thin and feeble; their appetites are voracious; they are always hungry, always crying for food; in spite of the large quantity they take, they waste more and more, and unless some addition be made they die of atrophy. They are starved to death, fed on starch, which they cannot digest. These wretched children were known at one hospital as "corn-flour children." For all children under two or three years old, arrowroot and corn-flour are the poorest and least useful of foods.

Prepared barley, sago, tapioca, or rice, are open to the same objection, in varying degrees. Oatmeal is more nutritious, as containing more albuminates, fat, and salts, but is unsuitable for young infants, since it contains a large amount of indigestible matter. The best of all the farinaceous substances is the entire wheat-flour, not the coarse kind, but that specially prepared for children and invalids, of extreme fineness. In this the inner portion of the husk of the wheat is separately ground down to finest powder and added to the flour, which thus contains the whole of the mineral matter and all the albuminates. But even this is not fitted for young infants.

Rules for Bringing up a Child by Hand.—The quantity of food to be given at a time varies a little with different children. For the first month, 3 to 4 ounces—that is, 6 to 8 tablespoonfuls—is usually sufficient; but an exceptionally robust child will sometimes take 6 ounces, or even more, before it reaches the age of three months. The quantity must be increased, but this must be done cautiously and gradually as time goes on. Nature indeed provides a remedy for over-feeding. An infant's stomach readily rejects any excess of quantity; but, still, habitual over-distension is apt to cause flatulence and discomfort, perhaps diarrhœa, and induce a habit of vomiting, which may seriously interfere with health.

With regard to the times of feeding children brought up by hand, the same rules must be followed as those previously laid down for feeding infants at the breast.

The best kind of bottle is the old-fashioned, long, straight one, used in former days with a calve's teat on the nozzle; but an Indian-rubber teat my be used instead. The feeding bottles with long flexible tubes are most popular with nurses because they are far the most convenient. They can be placed in almost any position, and the nurse can leave the child to take the bottle lying down in bed without assistance. This is in itself a grave objection to their use, and another equally great is the extreme difficulty—almost the impossibility—of keeping corks and tubes absolutely clean. The minutest particle of sour material in these appliances is sufficient to taint the whole milk, and become a source of sickness and diarrhœa.

The importance of securing the perfect purity and freshness of the food can hardly be exaggerated. Milk is most treacherous in this respect; as soon as it is drawn it begins to decompose under ordinary conditions. Professor Lister has shown that this is due to a minute germ—the *bacterium lactis*—which sets up fermentation, and hurries on decomposition by its rapid multiplication, just as the yeast plant governs the fermentation of beer. The smallest appreciable atom of sour milk probably contains a swarm of such germs, and is sufficient to set a whole bottleful in rapid decomposition.

After each time of using the bottle should be at once emptied of any residue, and rinsed out with warm water; then placed in fresh hot water to soak for some time; after that rinsed out again in fresh water, and placed in an airy place to drain and dry. If a bottle with tubes and cork be used, these parts must be cleansed in a similar way with even greater care. Every morning the whole apparatus should be cleaned with warm water, in which a little soda has been dissolved, and this carefully rinsed away afterwards. The child's mouth must be regularly sponged after each meal to remove all adherent particles, and the food-soiled bib changed for a clean one. The closest watch must be kept over the cans in which the milk is brought. They are constantly slightly sour. Milk is often spoilt by the introduction of the agent of decomposition from the supply can.

All vessels in which milk is received should be scrupulously clean; and the store should be kept in a fresh airy room. Milk is an exceedingly delicate and susceptible fluid, affected very readily by a foul or unwholesome atmosphere. It ought never, therefore, to be kept in either the day or night nursery, in a close room, or indeed in any room which is inhabited, where the air must necessarily be in some degree tainted with organic effluvia, no matter how well-aired and clean it may be. To sum up—milk must always be kept in a clean earthenware bowl or jug, in a cool airy pantry; and that which is for nursery use, at any rate, should be boiled the moment it comes in.

Another source of danger lurks in the food warmers. The common custom of leaving the food in the pan and keeping it warm during the night by means of a light beneath it is most objectionable. The heat is insufficient to keep the liquid simmering, the gentle warmth favours fermentation, and the food turns sour.

The right plan is to keep the food cold in a small jug or basin, and transfer it to the warmer, and light the lamp only when it is to be used; or the lamp may be kept lighted, and the water in the receiver thus heated ready, the food being kept cold in a basin apart, and placed in the warmer at the time of using.

Progressive Changes in Diet.—If the child be suckled and the supply of breast milk is ample, it should have no other food of any kind for the first six months. If the mother or wet-nurse has not sufficient milk, this should be eked out with milk-and-water or condensed milk or bread food, given at regular intervals, in addition to the breast, as previously laid down. And, similarly, if the child be brought up entirely by hand, it should have milk, or whatever suitable preparation may be chosen for the bottle, and nothing else.

At six months the food may be slightly thickened by a scalded rusk, or Robb's biscuit, or, better still, some thoroughly boiled fine entire wheat-flour, or malted food. If the child has been suckled entirely to this time, food of the kind may be gradually introduced, beginning with one meal a day according to the supply of breast milk. At eight months the baby should have a little broth or beef-tea—half a small teacupful at first, once a day—in addition to its staple food. It should be completely weaned at from ten to twelve months.

At twelve months it may have a light milk or custard pudding, made of the wheat-flour, as well as beef-tea at the midday meal.

When the child is fifteen months old, if it be robust and of strong digestion, it may have a little boiled bread-and-milk, and once a day some under-done meat, beef or mutton, carefully scraped into the finest pulp, and moistened by beef-tea or gravy poured over it, or a little chicken prepared in the same way. If the child is delicate the change must be introduced slowly and cautiously.

As the child grows older the meat may be increased, and it may have a small quantity of thoroughly-mashed potato. At two years it may be advanced to four regular meals—a breakfast of bread-and-milk, or porridge-and-milk, or an egg; a dinner of meat or fish or chicken, with a small quantity of well-mashed potato, and a light milk or egg pudding; a tea of bread-and-butter and milk, with a little fruit-jelly or treacle; for supper bread-and-milk. In some cases, when breakfast is very early, or the child a small delicate eater, a fifth meal may be necessary, in the shape of a plain biscuit and drink of milk at eleven o'clock, although, as a rule, all intermediate feedings are objectionable, blunting the appetite for regular meals. Milk should be the great staple of food for children up to two years old. They should be allowed a pint and a half to two pints of pure good milk up to eighteen months; and, if they do not take meat well, even up to two years. But after the first year the amount of milk a child can take and digest does not always supply all the animal matter required for the most perfect nutrition, and thus broths or beef-tea at first, and later *meat*, are useful in addition.

The addition of beef-tea and meat to the infant's diet is here set down for a far earlier period than is ordinarily adopted or recommended. There is an idea that meat is not suited for young children, and nurses and parents, and often doctors too, are eager to add some farinaceous food—a rusk or nursery biscuit—which an infant can ill digest, while they religiously avoid giving beef-tea and meat; and yet little children digest broths and beef-tea, and even meat, extremely well if it be properly prepared. They do not grow rickety or ill-nourished on meat-diet.

If a child has chronic diarrhœa and wasting, generally produced by improper food, it should be fed entirely on raw meat, and it will thrive on that alone. As a matter of fact children do not very often suffer from any excess of animal food. Occasionally meat given in excess disorders the stomach, or sets up gravel; but this only happens when it is taken too freely in addition to other animal food, such as milk, eggs, and butter.

In truth, far greater danger lies in the other direction. After the first year the child begins to take bread-and-butter and biscuits. These articles of food are convenient and handy; the child likes them, and before long, perhaps, bread and biscuit become the staple of its diet, to the exclusion of a full proportion of animal food. It gets bread-and-butter and a little milk for breakfast, and a biscuit for luncheon; dinner perhaps comprises some meat or beef-tea and pudding, while tea and supper consist of bread with treacle, or jam, or butter, and a small quantity of milk only to drink. Thus the child, though feeding well, grows soft in muscle, soft in bone, fragile of tooth, and backward in teething, which proves irritating, slow, and painful.

I would insist again that children are naturally animal feeders in early years, that children fed on animal food are the most robust, and that for them to attain perfect development they must be supplied with a sufficient amount of it. If milk be taken freely, and well digested, that is usually sufficient; but if not, its place cannot be supplied satisfactorily by any vegetable material. Some other animal food, such as beef-tea, meat, or eggs, is the essential substitute.

After the child reaches two years the diet-table may be somewhat further enlarged. The regulation breakfast of bread-and-milk may be varied by oatmeal porridge with milk or treacle, or an egg with thin cocoa-and-milk, and bread-and-butter.

At dinner the meat may be varied by fish or chicken, and in addition to potatoes well-boiled vegetable marrow, or cauliflower, or soft young peas; stewed fruit with batter or rice relieve the ordinary farinaceous pudding; at tea-time, cocoa, or tea-flavoured milk, with bread or toast; a drink of milk and a biscuit may form the final meal at bed-time.

Thus the child passes on to the usual diet of the elders, the food being always plain, simple, and nutritious. A growing boy or girl of six or seven in active exercise should have meat twice a day—viz., at breakfast and early dinner, unless the habit of earlier life, of taking milk largely, be still kept up; then meat once a day is sufficient. Occasionally one meets with children who show a curious idiosyncrasy with regard to meat. They have so strong a dislike to it in any form as to suggest the idea that they had sprung from a race of vegetable-feeding ancestors. It is better in such cases not to insist upon meat being taken, but to supply the essential animal aliment in the form of milk and eggs.

Over-feeding.—There is comparatively little danger of over-feeding in the sense of giving too great *a quantity* of food. An infant's stomach usually rebels against the excess at once and rejects it; this faculty remains in some degree throughout child-life, and acts as a sufficient protection in most cases, so that over-stuffing is cured by vomiting. There is a danger of over-feeding, however, in another form, from a practice which is very seductive to parents—viz., that of giving a child additional food at the family meals. The child has its own breakfast in the nursery perhaps, and is brought down to see its father before he goes out for the day, sits beside him or its mother, and is fed with delicate morsels from the parent's plate; when it gets a little older it is brought in at dinner also, and has a taste of soup, or fish, or entrée, or cream. Parents are not the only offenders; a similar indulgence is too often practised at the nurse's meal times. This extra food, often rich and unsuitable, comes between ordinary feeding-times, so that the child's stomach is excited to fresh efforts of digestion, is deprived of due rest, and the appetite blunted for wholesome nursery diet. Hence arises a fruitful source of evil. The child feeding more and more upon unsuitable food, such as its parents and nurse have, becomes bilious, has vomiting or diarrhœa from over-rich indigestible diet, falls out of health, or develops rickets from lack of due proportion of the elements essential to proper growth.

Lastly, there are certain articles of food and drink which should be avoided as unsuitable for and even injurious to young children. Amongst these are raw fruits, such as apples, pears; uncooked vegetables, such as radishes and celery, which contain woody fibre absolutely insoluble in their gastric juices. Some vegetables, such as cabbage, stalks of cauliflowers, and spinach, even when cooked, still contain much insoluble matter; carrots, potatoes, and vegetable-marrow, on the other hand, if thoroughly boiled and beaten up, are digestible. Nuts, again, are absolutely indigestible in an infant's stomach; pastry is another most indigestible form of food. The butter intimately mixed with flour interferes with the action of the gastric juice upon it; and the fat retained in the stomach, instead of being passed on to the first part of the bowel, where its digestion properly commences, begins to decompose and form an irritant acid. Buttered toast and tea-cakes are, in less degree, open to the same objection.

Chocolate, again, is a nutritious food in itself, but given in the form of sweetmeat or cream indiscriminately, at odd times, nauseates, spoils the appetite, and disorders the stomach. Sweets which contain indigestible materials, such as almonds, carraway seeds, or cocoa-nut, are always objectionable. A simple sweet, such as barley-sugar or acid-drops, consisting of almost pure sugar, is harmless in itself, and an occasional one may be allowed, but given too largely they pall appetite and disorder digestion. In the same way cakes which contain raisins, currants, carraway seeds, all of which are indigestible by young children, may give rise to severe stomach-ache, or vomiting and diarrhœa. The only cake admissible in the case of young children is a light plain sponge cake. Plain biscuits, such as Osborne or Oswego biscuits, may also be given at proper times as an adjunct to meals.

Alcoholic stimulants should never be given to children, except as a medicine by the doctor's order. There is a popular belief—now happily dying out to a great extent—that wine, and beer, and brandy, represent a sort of liquid strength, which can be poured into the body to give life and vigour to it at will; yet in truth, although alcoholic drinks do in some degree furnish nutriment to the body, their chief effect is as stimulants—*i.e.*, to increase the force and frequency of the heart's action. They appear to have the further effect of retarding chemical changes in the living body, just as we know they stop such changes out of the body. If we wish to preserve any animal substance we place it in spirit, and the changes of decay cease; it is preserved exactly as it was. Such influences may be useful in certain exceptional conditions, but not in the state of ordinary health.

In the case of children, indeed, this power of arresting chemical action is especially injurious. Rapid changes are essential to the processes of vigorous development and repair. We do not want to maintain the *status quo* in growing organisms, and thus to dwarf and stunt and dwindle them, but to give constructive force free play. In so far as alcohol checks this, its influence is evil. Further, it is desirable that in health the child's heart should beat, the blood flow, and the circulation go on by its own natural power unaided by artificial means; and thus alcoholic stimulants, by driving this part of the machinery at an increased and unnecessary rate, do harm again.

Stimulants are amongst the most potent and valuable agents as medicines in the hands of the physician. As articles in the daily diet of a healthy child they are injurious to the free growth and natural vigour of youth.

Air and Light.

Air and light are essential to the development of the higher forms of animal and vegetable life in full vigour and perfection.

The lowest organisms—fungi, and bacilli, and bacteria, whose office in nature appears to be to prey upon and hasten the decomposition of their superiors in the scale of life—love, like other evil things, darkness and close dwellings. Bright sunlight and fresh air are as inimical to them as they are beneficial to the more perfect forms above them.

In giving light and air to our children, then, we favour their healthy growth and repress the growth of noxious germs, destroying also decaying atoms and foul gases, which are fruitful parents of degeneration and disease.

Air is the source whence oxygen is obtained by the body, and oxygen is the chief agent in effecting chemical changes in it. By oxygen the portion of food used as fuel is burnt, and heat and all forms of energy evolved. Oxygen is required for the changing and removal of waste, and unless the used-up matter be displaced, and carried out of the body easily, quickly, and unceasingly, the new materials cannot be put in its place in the work of repair and growth. In this renewal and fresh building again oxygen plays an active part.

The action of light is known with less precision than that of oxygen. It appears, however, to be essential to the perfect formation of the red cells of the blood—its most vital constituents. Persons who are deprived of light grow pale and bloodless. Young women brought from the country as servants or shop girls, and kept in cellar kitchens, or dark work-rooms, notoriously suffer in this way. Miners also are a pallid anæmic class. The want of fresh air has something to do with the result no doubt; yet patients in a well-lighted hospital ward appear to recover more quickly, as a rule, than those in darker rooms, equally well ventilated. Altogether, common experience and observation confirm the conclusion which science has hardly yet formulated, that light has a powerful and favourable influence upon animal life. Human beings grow blanched, just as plants do, for the want of it. And it is not a question of colour merely; vitality is seriously lowered also. This is largely felt in great towns shaded by fog and smoke-clouds.

Some recent remarkable experiments have shown that the electric light exerts a favourable influence on vegetation, second only to sunlight. It is possible that it may in like manner foster animal life, and that if the streets and houses of London come to be brightly illuminated by its agency, the inhabitants may gain something more for health than the clearing of the atmosphere of poisonous products of gas and coal—a substitute for lost sunshine.

Oxygen enters the body through the lungs, which are engaged, day and night, waking and sleeping, in absorbing it, and in casting out the waste carbonic acid and organic vapour. Now it is of importance that the air drawn in should be not only rich in the vital oxygen, but also free from impurities.

Through this door of the lungs many noxious things find entrance. The atmosphere of large towns, dwellings, and places where living beings are collected together, is found to be not only tainted with poisonous vapours from fires and gas, and exhalations from animal bodies, but loaded with countless minute atoms, a cloud invisible to ordinary sight, but betrayed by a ray of light passing into a darkened chamber—the motes which dance in the sunbeam. These motes are some of them harmless specks of earth, some injurious particles of decaying matter, spores of fungi, ova of insects, with here and there amid the millions, a deadly atom of contagion or germ of disease, apt to inoculate with fever, or other infection after its kind. On the other hand Professor Tyndall has shown that the air, thousands of feet above the sea level, which floated thither in virgin freshness, innocent of contact with the dusty earth, is almost absolutely pure—purer than the atmosphere of mid-ocean. The air of the open country at the ordinary levels, although full of atoms, contains comparatively innocent material, gathered from the soil and vegetation of the surface. The perfect atmosphere of lofty altitudes, the clean breezes of the open sea, are practically out of reach. Common, healthful, country air, as pure and free as may be from taint of man and all his works, is the best available.

For the great mass of people who live in towns even this is impossible in perfection, except when a strong gale sweeps the streets, and scours the courts and alleys. In the still, hot, summer days or when winter fogs prevail, the air remains unchanged and loaded. Happily some purification is constantly going on through the action of oxygen, the diffusion of gases, the washing of the air by rain, or life would become impossible; and thus, in ordinary times, with free play of breezes, the air outside is far better than that within the dwellings. Experiments prove that the atmosphere of living rooms by day, and sleeping rooms by night, gradually becomes deteriorated; every breath drawn in drains it of oxygen; every breath given out adds impurity to it; and the accumulating exhalations must be diluted, and fresh oxygen added, to render it fit for respiration.

Day and Night Nurseries.—How to secure a full supply of light and of sufficiently pure air for children, under all circumstances, is a problem of no small difficulty. It is to be done in two ways: light and air must be brought to the children indoors, and the children must also be taken out into the light and air.

The first point involves the whole question of the arrangements and management of day and night nurseries. These should not be on the ground floor, at the level of damp and noxious emanations from the soil. In a country house they may be on the first floor. In towns, especially in a large town like London, they should be at the top of the house, in the purer upper stratum of air, above dust and effluvia from drains and sinks and dust-bins. Care must be taken, too, that no ventilating pipes to sinks or closets or drains leak or discharge near by—either within the house, or in the neighbourhood of the windows outside.

The rooms should, if possible, have a southern, or, at least, a sunny aspect. Direct sunlight is the most potent and valuable of all light. In summer such rooms are rather hot, but if they are large this can easily be remedied by sun-blinds. In this land there is so little sunshine that an excess of it is a slight and passing evil not to be compared to the deprivation of it.

The day and night nurseries should be apart, separated, if possible, by a passage, so that when one room is in use the other can be freely ventilated by widely-opened doors and windows. It is a common plan to have the two rooms opening into one another, and this is no doubt extremely convenient, but it has the disadvantage of hardly ever leaving either quite free from occupation. On the other hand, there is the small advantage, that at night the door of communication can be left open, and the sleeping chamber have the benefit of the volume of air, and, perhaps, an open window in the day room. The windows should be large enough to admit abundance of light, and should run up to the top of the room, so that the upper sash opens level with the ceiling, otherwise a stratum of foul air accumulates in the space between it and the top of the window.

Both nurseries should have open fireplaces. In cold weather, and with very young babies or delicate children, or in case of sickness, fires may be required in both; and a chimney is an excellent ventilator; even when there is no fire it admits fresh air by down draught, in addition to carrying used-up air out of the room.

A child should therefore never be allowed to sleep in a room without a fireplace, and the chimney must be open, unblocked by "Register" valves or wooden barriers, which over-careful housekeepers are so ready to put in for the protection of grate and fire-irons against the down-fall of rain or damp. No stoves of any kind or hot-water pipes should be used in either day or night nurseries, since they affect the air injuriously, and aid little in ventilation; gas stoves are the most objectionable of all, especially those forms of them which have no pipe or chimney to carry off the products of combustion.

Space to be allowed each Child.—The rooms should be lofty, at least ten feet from floor to ceiling, and as large as possible. Too little attention is usually paid to this; or the exigencies of position prevent practical observance of the rule. Children are constantly crowded in one or two small rooms in numbers which render a sufficient supply of pure air impossible, and after a fashion, which in the case of adults (except, indeed, unhappy servants relegated to garrets) would at once be recognised as unwholesome and intolerable. Elaborate and repeated experiments have proved that each grown person requires a space of at least 1,000 cubic feet, in order that the atmosphere may be kept sufficiently pure by a supply of fresh air, introduced so gradually that there shall be no uncomfortable or dangerous cold blast. If less than this be allowed, air has to be brought in so rapidly that it causes objectionable draughts.* Each child under seven years old should have at least 800 cubic feet; if older than that, the same as an adult. From this the number of children who may safely be allowed to sleep in a well-ventilated room of given size may easily be calculated.

Thus, a room 20 feet long by 12 wide and 10 high—the average size of a fair bed-room—would contain 2,400 cubic feet, and would afford space, therefore, for two adults, or three children, or one nurse and two children, if the latter are very young Each child should have a separate cot standing alone with a clear space of air round it. The nurseries should not only have chimneys to aid doors and windows in the work of ventilation, but should be fitted with Tobin's tubes. These are simple metal pipes brought in from outside and carried vertically up the wall inside the room to a height of seven to eight feet. The air admitted from without is thus discharged into the room well above the heads of the occupants, and the stream being directed upwards toward the ceiling gradually spreads and diffuses through space without perceptible draught. The tubes should be fitted with a valve or tap, by which the air may be shut off on occasion, and should be carefully swept out from time to time.

All ventilators in doors or walls, or Sheringham's valves above the windows, are objectionable in the nursery, because they invariably set up cold draughts of more or less severity. Tobin's tubes are the only contrivances which are satisfactory in this respect. By their means rooms can be kept perfectly fresh without danger of chill. The next best device is that of raising the lower sash of the window by a three-inch board fixed beneath. By this means air enters by the space between the upper part of the frame of the lower sash and the glass of the upper sash, and is directed upwards, after the manner of a Tobin's tube.

Lighting.—Another vital point in relation to the purity of air in rooms is the method of artificial lighting. Gas-lights should never be admitted into a nursery or play-room. No perfection of burner, no degree of ventilation which is practicable, will render it harmless; even when gas is completely consumed, it gives off a vast quantity of carbonic acid, with some sulphurous acid and ammonia—all products more or less injurious. When the gas is imperfectly consumed, as is the case with ordinary burners, carbonic oxide, a still more poisonous product, is given off also. All these noxious vapours escape into the air of the room. Gas, again, exhausts the air rapidly. It is calculated that each gas-burner using three cubic feet every hour absolutely consumes the oxygen of 24 cubic feet of air in that time. A man breathes in only 16 cubic feet, and does not use the whole of the oxygen contained in it. Each gas-burner, again, produces 6 cubic feet of carbonic acid every hour, or ten times as much as a man, who produces only ·6. So that with regard to the vitiation of air by carbonic acid one gas-burner is equal to ten men. Since, however, the gas-burner does not give off the still more deleterious organic matter exhaled from living beings, the air is not rendered injurious in the same degree. It is calculated that, allowing for this, at least 5,400 cubic feet of fresh air should be supplied each hour for each burner, in addition to the 3,000 required for each person, or 8,400 cubic feet in all, in order to keep the atmosphere at the degree of purity necessary to health: that is, containing not more than ·6 of carbonic acid per 1,000. How impossible it is to carry this out practically will be seen at once.

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* Each adult requires a constant supply of 3,000 feet every hour, in order to dilute the exhaled matter sufficiently to form an atmosphere fit for respiration. To do this in a space of 1,000 feet, the air would require to be changed three times every hour, which has been found by experiment to be the limit of frequency at moderate temperatures without objectionable draught. Children require more air in proportion than adults, for the vital processes are more active. For infants, perhaps, one half the air required for an adult would be sufficient, and, therefore, one half the cubic space, or 500 cubic feet; but for children above one year old it is well to allow 800.

Further, gas evolves a vast amount of heat. Each burner gives out each hour enough to raise the temperature of 93,770 cubic feet of air 1° Fahr., and the effect of this heating power in a room of moderate dimensions—say 2,400 cubic feet—must be very great, in spite of the constant cooling process going on by the escape of heated air and the ingress of cold. Any one who will ascend a step-ladder in a room fully lighted with gas, so as to bring his head into the upper stratum of air next the ceiling, will be able to judge of the heat and foulness of the air produced by this insanitary agent. It is impossible, then, to keep the air of a nursery either sufficiently pure or sufficiently cool if gas is used to light it.

The typical light for a nursery would be the incandescent electric light of Edison—one which gives out no appreciable heat, neither consumes air nor fouls it. This is hardly available for the purpose yet, although it probably will be at no distant date; and in the meantime oil-lamps or candles, yielding simple carbonic acid and water, and free from the deleterious compounds which issue from gas, must be used. Petroleum lamps are the least desirable, on account of the large amount of heat given out, and the highly-inflammable nature of the oil. Colza oil is comparatively safe, affords ample light, and gives out much less heat. A moderator or other lamp burning this oil, or candles, are to be preferred.

The air of the nursery, again, is liable to be contaminated by soiled clothing. The practice of drying napkins at the nursery fire, often followed by nurses, should be strictly forbidden. Dirty linen of every kind should be immediately removed out of the room.

A great help to the cleanliness of a nursery, especially in a large town, is to have it clear of curtains and carpets. The floor should be covered with linoleum or kamptulicon, which is sufficiently warm and can be regularly washed. The walls should be painted, so as to admit of washing also; or if paper is used, it should be renewed every year. The old paper should be thoroughly scraped off, and the walls well scrubbed down with a solution of carbolic acid, before the new paper is put on, for paste and plaster are great harbourers of foul matters and contagion.

In addition to the ventilation in constant operation, the rooms should be daily flushed through with air, when the children are not occupying them, by opening freely all doors and windows. The only exception to this is when a dense smoke-fog, such as those of London, renders the outside air, loaded with carbon and sulphurous acid, more injurious than that within. Even when keen frost, or east winds, or rain prevail, the windows and doors should be thrown open in this way. They must be closed again and the air warmed some time before the children are re-admitted.

Airing out of Doors.—The question of taking children out of doors is one which often leads to domestic discussion; indeed, it is one of great delicacy, and often most difficult to decide. With regard to very young infants it may be laid down that they should be kept in warm airy rooms, within doors, at any rate for the first month. They may then be taken out, protected from the sun and wind by sunshade or veil, on the first fine warm day. When born in late autumn or winter, however, children should be kept within doors until two months old, unless unusually warm and genial weather sets in before. Sensitive delicate infants must be kept back longer still, and may have to remain indoors the whole winter if the season be severe.

Until children are able to run about freely they should not be exposed out of doors for long in cold weather. In a perambulator they soon get chilled, in spite of wraps; the nurse's arms are safer, and she should walk constantly about with the child for the whole time it is out. This gentle movement affords excellent exercise for the infant.

Older children who are fairly robust, and are able to play about, should be taken out every day, and in nearly all weathers. Well wrapped up with thick stockings and flannel drawers and under-shirt, they will not feel the cold unduly, even in a sharp north wind, when taking active exercise in the keen fresh air. The exceptions to be made are in the case of bitter easterly winds, fog, and steady rain. At such times little children, however strong they may be, are safer within doors. Delicate rickety children, liable to chest colds and bronchitis, or those who are asthmatic, must be kept with much nicer care. Should a healthy child even be obviously chilled and miserable at any time, it must be taken home forthwith.

In late autumn, winter, and early spring, the proper time to be out of doors is the middle of the day, when the sun is out. There is so little sunlight in this cloudy land of grey skies and gloomy weather, and light is such an important vital agent, that every advantage should be taken of its appearance. In the short dark days the nursery dinner should not be later than half-past twelve, in order that children may be out during the brightest and warmest hours—from half-past twelve to two.

In summer the outdoor excursion should be made in the morning and evening. If there is a garden, the children may be turned loose there directly after breakfast, and fetched in again to rest in cool shaded rooms as the sun gets power and the air waxes hot at midday; at four or five o'clock they may emerge once more, to play in the fresh cool air of evening.

Exercise and Rest.

Exercise is necessary for the various parts of the body, that they may work easily and effectively. This is true not only of ordinary muscles, but of all other organs. The lungs and heart, the brain and stomach, all decline in power and perfection of action if not exercised freely. Moreover, exercise is necessary to excite the demand for oxygen, required to burn up food fuel, to promote repair and fresh formation of tissue; Dr. Parkes found that a man took in eight and a half ounces more oxygen on a "work day" than on a "rest day." Even in the case of very young children, whose power of movement and action is so limited, exercise in proportionate degree is essential. The infant finds play for its muscles as it kicks its arms and legs about, and as it crows and laughs, or cries and screams, its heart beats faster—drives the nutrient blood faster; its lungs inflate more fully and take in more oxygen. This play in the cot or on the nurse's lap, the movements involved in being washed, dressed, and carried about, and tossed, and dandled, afford sufficiently active work for the organs and muscles of a baby. As the child grows older, and begins to crawl or run about, exercise grows more brisk and constant. There is no fear of this being over-done; the chief danger is of quite another kind—viz., that in playing on the floor the child may catch cold from the draughts which play along it from under the doors; these are but little noticed by grown persons, whose feet are alone exposed to them; but they are there, and prove common sources of chills to the little people who sit and scramble about in the full blast of the lowest level.

When the child is able to keep its legs well, the only precaution necessary is that it should not stand too much at first, lest the long bones of the legs become bent or twisted. There is little chance of this if the child is milk-fed and robust; but occasionally, even then, a very large and heavy body proves too much for the legs, although well made and strongly grown. If the child is flabby and rickety, its bones will be soft, and will bend even under the pressure of a comparatively light and delicate frame.

It is desirable that the exercise taken should be in the open air as far as possible, so that the increased demand for oxygen set up by exercise may be freely supplied with the purest material. The perambulator may be used for conveyance to the place of airing, and then if the child be old enough to run about it should be turned out to play; if it cannot walk it should be carried about in the nurse's arms. Walking is wearisome to children—the poorest of all exercise for them, giving the least amount of active movement for the maximum of fatigue, yet it is what they usually get the most of; the exertion of keeping the trunk erect, and balancing the body first on one leg and then the other, of maintaining equilibrium during a series of slow movements, is very great, and out of all proportion to the amount of motion attained.

Standing is still more fatiguing; the constant shifting from one leg to another in which a child indulges when standing waiting—often, alas! a long and weary while—for a gossiping or shopping mother or nurse, and the languid dragging of limbs at the end of a long regulation walk, are striking evidence of this, and should appeal to the mercy of thoughtless elders. The memory of my childish days is full of recollections of physical suffering of this kind.

Children require to move quickly, in brisk action, to save anything but a momentary strain upon the muscles—*i.e.*, to get the most exercise, the greatest amount of movement, for the least fatigue.

Little children suffer less perhaps in this way than those who are older. Girls especially are injured in this matter of walking; marched out day by day in wearisome routine. Perhaps in large towns there may be small choice, but where it is possible let hoop or ball, lawn tennis or riding, set the limbs in free and lively motion. These quickly changing movements give each muscle its turn, and refresh all, fatiguing none. Do not exercise children; let them exercise themselves in some congenial game or outdoor pursuit.

Rest.—As exercise is required for the due preservation of ready working order in the various organs, so, on the other hand, rest is necessary to afford an opportunity for their restoration and repair during a time of quiescence. The ordinary time of rest for a young baby at night should be at least twelve hours, in spells of two or three hours each, part of the time between being occupied in feeding. The waking day-time, on the other hand, is largely encroached upon by sleeping; a healthy infant, if satisfied and comfortable, will sleep the greater part of day and night during the first few weeks after birth. The day-sleeps will grow shorter as the child grows older, the night-sleeps longer. Thus, as the age of twelve months is reached, there will be a long night's rest of some ten to twelve hours, broken only once or twice by a waking up for food. During the day-time the child will sleep when carried or driven out, and will require one long rest of two or three hours at mid-day. All children, it is true, do not sleep and rest so regularly and largely as this. Infants, as well as grown persons, sometimes exhibit curious idiosyncrasies in this respect. Now and then we meet with a perfectly healthy child, to whom wakefulness at night and slumbers by day appear the natural order of things; and others to whom settled prolonged sleep, either day or night, appears to be as physiologically unnecessary as it is clearly uncongenial. They hardly sleep at all, and yet their health does not perceptibly suffer. During the time of teething, many children, otherwise good sleepers, are subject to this wakefulness—become feverish, restless sleepers. For this it will be well to take medical advice.

It is wise to keep up the habit of a mid-day rest, if possible, until the child grows to be three or four years old. In winter-time this practice no doubt interferes somewhat with the going out during the warmest and brightest part of the day. It can, however, be arranged by making the dinner early, and sending the child out immediately after, putting it to rest as soon as it returns. In summer, when the season is a hot one, however, this practice of a mid-day rest is an unmixed advantage. The child is kept cool and quiet during the sultry hours of blazing sunshine. It should be undressed—at any rate partially—lightly covered with a thin blanket, and the room kept dark by blinds or shutters. The stimulus of light is not needed, and is, indeed, unfavourable, to the desired inactivity of the parts and functions, during sleep.

At night the child should rest in a roomy cot alone, with sides of free open-work fitted so as to take out on occasion, covered with sheets and light warm blanket; counterpanes of all kinds are objectionable. They are usually cumbersome, heavy, and oppressive out of all proportion to the warmth they yield—being made of cotton, which is heavier and less warm than wool, and of texture too close to admit of the free escape of perspiration. A blanket is the ideal covering—light, warm, porous; a bright coloured blanket makes an excellent substitute for the ponderous quilt.

It is advisable for children to sleep in a flannel night-dress, fitting over the ordinary linen or cotton gown, the bed-clothes being reduced in proportion, so as to prevent over-heating. By this means they are always sufficiently protected, let them kick about never so wildly, and the maternal anxiety about the child getting uncovered, and the nightly practice of "tucking in" may be safely abandoned.

CLOTHING.

Objects and Properties of Clothing.—The chief purpose of dress in a cold or temperate climate is that ordinarily assigned to it—viz., to keep the body warm. But this statement by no means expresses its whole function. To say nothing of the subsidiary ends of a decent covering for the body, and the æsthetic result as a means of ornament and attractiveness, clothing serves to keep the body cool as well as warm. The Asiatic or African under a burning sun clothes himself in loose cotton robes, with straw hat or turban, to protect his body from external heat, while the Laplander or Eskimo wraps himself in furs and skins to protect it from the external cold. The temperature of the body must be maintained at or about 98°·6, with very slight variation, under all circumstances. If raised above this, it at once produces feverishness, with all its accompanying evils; and if the rise is considerable, as seven or eight degrees, and persists for more than a short period, it is fatal to life. In the same way a fall of temperature leads to marked depression of vital power, and if considerable and long-continued leads to fatal collapse. It is remarkable how accurately this standard of ninety-eight and a half degrees is maintained in health under the most diverse conditions of surrounding temperature. There is a wonderful and delicate power of regulating heat in the bodily machinery, so that its temperature is preserved the same in arctic regions as in the tropics. Yet the aid of dress is useful, and generally essential to the preservation of the natural heat. Savage races find it possible to dispense with clothes in a warm climate. In a cold one life could not be maintained without them.

In a hot atmosphere the temperature of the body is kept down by the evaporation of copious perspirations, and moreover can be protected from the direct rays of the sun by shade. In arctic cold no amount of heat-producing exercise, or food within, or any device whatever, will serve to keep the temperature up to the necessary standard, unless the abstraction of heat from the surface by the cold air outside be barred by some encasing substance which will not allow it to pass unduly. Yet the covering of the body by clothing, essential as it is in cold, and useful in warm climates, brings with it certain evils. It cannot be always exactly adapted to the surrounding temperature, and sometimes keeps in the body warmth too closely, unduly heating it. It interferes with the perfectly free passage of evaporating moisture, absorbing and retaining waste matters from the skin, which tend to decay and foulness, and which in the uncovered state of nature would be washed away by wind and rain, or destroyed by oxidising air. Dress again, be it never so light and easy, necessarily restrains in some degree the free movements of the limbs, and exerts injurious pressure upon various parts and organs.

The rules of healthy dress, then, have respect to the material of which it is made—its texture, colour, and the form in which it is arranged. In the first place it should be as light as possible, so as not to hamper movement, or load the frame with a burdensome weight. In the next place it should be of porous material, so as to take up the sensible perspiration, and permit the free passage of the insensible or vaporous perspiration through its interstices. In very cold windy weather the texture of an outer garment should be close, so as not to permit the passage of chill air. Materials of open texture are warm in a still atmosphere, the air contained in the interstices being a non-conductor; when, however, air is constantly changed, as in a cold blast passing through, it abstracts heat rapidly, each fresh portion of cold air carrying off some, and the cooling process thus goes on apace. Further, clothing must be made of a material which is a non-conductor of heat, so as to preserve the natural warmth generated within the body from passing out, and equally to prevent the heat from without passing in—thus preserving the temperature at an even standard, with as little variation as possible.

Dress, again, should be of light colour during hot weather, as the light colours reflect back heat rays, and are therefore cooler; but in winter it should be of dark colours, which more readily absorb heat rays, and are therefore warmer.

Clothing, again, should be made of elastic materials, so contrived as to fit easily and loosely, yielding to, and not restricting, movement; and, further, arranged to cover amply the chest and body where the vital organs lie, yet not pressing unduly or unequally upon them.

The warmest of all materials used for clothing is fur—the animals' dress, designed especially, admirably adapted, and indeed necessary, for an arctic climate. It is the most treacherous of all coverings in the temperate climate of England, except for protection against cold during inaction, as in driving. For active exercise it is utterly unsuited; it is heavy, inelastic, and not porous; thus it is extremely liable to cause chill by over-heating and not allowing free escape of moisture.

The next material in point of warmth is made of another animal-covering—wool; and this has been adopted by universal consent as the most suitable for temperate climates, just as skins and fur are the most suitable for the regions of ice and snow, and cotton for the tropics.

Silk stands next in rank to wool; it is a non-conductor of heat, and is warm, therefore, as well as extremely light. It is excellently adapted for clothing in every way, possessing all good qualities in high degree; but from its great cost its use is practically restricted to ornamental additions to costume, such as scarves and ribbons, except in the case of ladies' dresses, and as underclothing for some luxurious persons who can afford to use it instead of woollen.

Cotton is the chief material used for body clothing next to wool; it is a slow carrier of heat, and hence fairly warm. It has almost entirely superseded linen on account of its superiority in this way, and its extreme cheapness. Linen has the advantage in endurance, softness, and delicacy; but it conducts heat too freely, cools the surface too rapidly, and of course also protects it but feebly from external heat.

Any one who has stepped into a bed with linen sheets on a cold winter's night will have realised very keenly their power of abstracting heat from the icy chilliness they convey. When they were in vogue the warming-pan was an essential element of comfort; now, however, linen having been superseded by cotton, it has fallen out of use and become an obsolete curiosity.

Essentials of Healthy Dress.—The due observance of the laws which govern healthful dress is of more importance in the case of children than with grown persons; and yet in no instance are these laws so commonly and so grossly transgressed, except, perhaps, by fashionable women. Children have at birth but feeble circulation, low breathing power, the oxygen moreover being partly used for forming new tissues, and, therefore, they have defective power of producing heat; they thus require special protection by clothing of soft and warm materials.

Their bodies are constantly expanding in daily growth. The bony framework is soft and yielding. Free movement is almost a necessity of existence. Upon them, therefore, a tight or rigid or heavy casing, by pressing in the ribs on to heart or lungs beneath, or oppressing the delicate organism by burdensome weight, inflicts more injury than on the more rigid and resisting form of the full-grown adult. An infant, with its soft, flexible, almost boneless body, with the machinery necessary for carrying on an independent existence which it contains, still in imperfect working order, requires exceptional care in this respect. A young child should be clothed from head to foot in woollen. Next its skin, easily frayed and chafed, it is usual to place a shirt of finest lawn—the least irritating of all materials. To obviate the heat-abstracting power of the linen, a gown of the finest flannel, loosely and easily fashioned, must be worn. Flannel is the type of a perfect material for dress; it is a non-conductor of heat, and is light, porous, and elastic. If linen be not used, the flannel gown may be worn next the skin, and this is perhaps on the whole the safest and wisest plan.

Round the waist and body, a roll of flannel is usually wound as a "binder," with a view of supporting the navel, and also of protecting that portion of the body against cold. This is useful and advisable, if not drawn too tight, so as to exert injurious pressure and interfere with the action of the chest and diaphragm in respiration. Napkins should only be worn when the child is carried about. When at rest it should lie free and unbound, resting upon one double folded. A waterproof over-covering, often favoured by nurses, should never be allowed. The constant wearing of napkins, which are necessarily frequently wet with irritating fluids, heats the skin and renders it sore and inflamed. This practice is a common cause of troublesome eczema, which the use of a waterproof outer napkin only aggravates. A wet or soiled napkin should be instantly removed, and a perfectly clean one substituted; one which has been merely re-dried must never be used again without washing, according to a common and uncleanly practice.

The baby thus dressed with linen shirt, long-sleeved flannel gown, loosely fitting, with the addition of a flannel shawl on occasion, is comfortable—it is warm, and unrestricted by pressure or tightness. Too often, however, it has to endure a bondage as irksome and unnatural as that of the Red Indian papoose strapped down to the moss-padded board which does duty for a cradle. The English infant is commonly encased in a linen or cotton dress, tightly fitting round arms and wrists, and round the neck closely-drawn strings which press on veins and muscles and windpipe, and by their friction irritate the tender surface.

When the child is old enough to go out its sufferings increase tenfold. A heavy merino or woollen cloak is tied round its short already overcrowded neck, pushing up the chin, chafing the tender skin, and hanging suspended, half strangling the unfortunate baby whenever it is raised to a sitting posture. A hat or bonnet or padded hood is pressed on its head, and the encumbered neck is still further choked by ribbon strings tied beneath the chin to hold on the unwieldy head-gear.

The child of a poor woman enveloped in a simple homely shawl is far more comfortable. This, indeed, should be the type of an extra wrap; instead of the regulation cloak, a loose woollen gown with arms may be used, if a simple shawl be deemed too unbecoming; and on the head a soft, light, woollen hood. In rough wintry weather the cloak should be made of closely-woven material, so as not to permit the chill outer air to blow through. At first, perhaps, it is well that the infant's dress should be long skirted, so as to cover the lower limbs completely, and keep them warm. But at the age of three months in summer—a month later in wintry weather—the child may be placed in short clothes; these should be of flannel, made with long, easy-fitting sleeves, and high at the neck, similar, in fact, to those described above, except with shortened skirts. Short sleeves and low-cut dresses should not be tolerated for a moment. The legs should be protected by light woollen gaiters, which become necessary now the lower limbs are no longer covered by the voluminous drapery of the first long clothes, and thicker ones should be worn upon going out of doors. Bare legs as well as bare arms challenge cold winds and draughts dangerously, are fruitful sources of colds and chills, and cause a feeble circulation in hands and feet.

The night-dress should be of flannel. Children are apt to throw off the clothing in their sleep, and a woollen body-covering of this kind—as I mentioned in speaking of the management of the night nursery—affords protection against chills, and relieves the mother's anxiety about the child becoming uncovered.

Socks are more suitable than stockings for children, since the latter usually require garters, which are most objectionable. The pressure they exercise on the vessels of the leg interferes with free circulation through the limb, is a constant source of cold feet, and is liable to give rise to varicose veins. If socks are worn, the legs should be protected by drawers and gaiters. If stockings are considered indispensable, they should be kept in place by suspenders attached to a waistband—an appliance now happily superseding the classic but injurious garter.

Boots and shoes, again, are a frequent cause of mischief. The object of coverings for the feet is to keep these members warm and dry, and also to protect them from being injured in walking by rough contact with stones, or other hurtful objects. The stiff shoes in fashion in this country are not adapted for childish feet. An infant should wear soft woollen socks, no leather shoes of any kind until it runs about; even then, in the house, soft buskins without stiff soles should be the only wear; better still, perhaps, the child should run with bare feet—a plan which has been adopted in one or two homes with excellent results. Out of doors leather boots must be worn, but these should be instantly replaced by soft shoes the moment the child comes in. This should be the rule with older children too, not only in wet weather for the sake of ensuring dry feet, but equally in dry weather, for the purpose of relieving pressure on the feet, and allowing them free play. In some extreme cases of weak ankles, boots with stiffening at the upper part may be necessary; but, as a rule, the support is better given by light wooden splints. However easy and well-made the boots may be, they cramp and confine the foot in some degree, and are fruitful in corns, bunions, bent toes, and chilblains; and the stiff soles prevent the muscles of the foot itself from exerting full spring and action.

The Red Indian, who wears moccasins of deer skin, soft, pliable, and fitting like a glove, has a muscular, rounded, perfectly-modelled foot, which enables him to walk with ease and grace at a pace which is unequalled except by highly-trained pedestrians here. He laughs with derision at the gaunt and skinny member of his civilised brother with its undeveloped muscle, and hideously distorted by the hard leather boot. The *best* formed feet to be met with in this country are amongst the children of the Scotch and Irish peasants, who go without shoes and stockings altogether; the *worst* amongst the Lancashire and Yorkshire factory workers, who wear clogs with unyielding soles of wood. The constant wearing of heavy shooting and walking boots with thick unbending soles has done much to deform the feet of the well-to-do folk in this country, as well as those of ploughmen and navvies.

Perhaps the game of lawn tennis, by affording almost daily outdoor amusement and exercise, in which the foot has free play in a soft, flexible soled shoe, may do something to redeem the evil. In this bleak and watery climate it is hardly advisable to abjure foot covering altogether, after the fashion of the Scotch and Irish poor—and not practicable to use the soft pliant moccasins of the Red Indian, which let in wet freely, and quickly break up under moisture. But the evil may be diminished by having boots made to fit easily, wide about the toes and instep, gripping closely the ankle only, and fitted with broad flat soles as flexible as may be. They should have low broad heels also—a point rarely attended to. Lastly, the use of boots should be limited to necessary employment out of doors.

WASHING AND BATHING.

Purposes served by Washing and Bathing.—The object of bathing is primarily that of cleanliness, but baths are used also for other purposes, as a cold bath for its tonic effect on the skin and system generally; a warm bath for its soothing influence on the system, or to promote perspiration; and baths of medicated waters for various specific effects upon the body. For the skin is something more than a mere outer covering to protect the more important parts within.

It is studded with sensitive nerve-fibres, spread over it in thousands of minute branches, endowed with a delicate sensibility, which convey to the central nervous system an intimation of every impression on the surface. A countless network of blood-vessels and lymphatics ramifies there; millions of sweat glands pour moisture on the surface; and sebaceous glands lubricate it with a constant supply of oily matter. So that the skin is really an elaborate apparatus for carrying on certain work necessary to the well-being of the economy. By its sensory nerve apparatus it supplies information to the ruling nerve centres. It helps to regulate the temperature of the body, preserving it by preventing the too rapid radiation of internal heat, lowering it on occasion by the evaporation of perspiration from its extensive surface—at one time raising, at another depressing temperature by varying the amount of blood in the superficial vessels. The skin removes waste matter discharged in perspiration—sebaceous matter, and shed scales of worn-out covering. The treatment of this complex structure, having varied and important functions and relations intimately affecting the vital organs, will obviously have a marked influence upon the bodily state.

The application of cold water, for example, by contracting the vessels, drives the blood from the surface to flood internal organs; chills the surface still more by the direct abstraction of heat; *raising*, however, the temperature of the blood generally by exciting an increased combustion of fuel elements to make up for the loss. It gives, moreover, a shock to the nervous system by its influence on the nerve-fibres, shown familiarly by the gasping and shivering it produces, which, if extremely severe, may be fatal; and it arrests for the moment the excretion of the glands.

The application of heat, again, relaxes the superficial vessels, increases the heat of the surface, and also directly increases the action of sweat and sebaceous glands.

The first chilling effect of a cold bath soon passes off unless immersion is unduly prolonged, when the body temperature may fall two or three degrees, and dangerous depression be produced. But ordinarily, after the bath is over, the state of chilliness of surface is reversed, reaction sets in, the vessels relax again; blood, raised to greater heat, now rushes back to the surface, and a warm glow follows. Similarly with a warm bath—the first rise of temperature, and relaxation of the superficial vessels, with increased flow of blood to the skin, is liable to be followed by a reversal of this—*i.e.*, contraction of the vessels, bloodlessness, and lowering of temperature, unless counteracted by friction and external warmth. Experiments have proved that either lowering or raising of temperature by artificial means is followed by a corresponding opposite deflection for a time, so that the temperature of the body is brought on an average to the normal standard.

Further, the soaking and scrubbing and sluicing of the skin remove the waste matter cast out by the glands, and shed from its scaly covering, which otherwise accumulates on the surface, and, decaying, contaminates clothes, poisons the atmosphere by foul exhalations, and affords a congenial soil for the harbouring and development of the germs of infectious disease. Whatever is left behind is a source of unwholesomeness. No frequency of change of linen alone will compensate for the neglect of frequent and regular washing of the body. The secretions and débris affect the outer clothing as well as the inner garments, through which they pass in some degree to lodge in the external parts of dress. This is commonly overlooked; yet all outer clothing requires to be freely exposed to the air from time to time, or purified by stoving or other means of disinfection. More important still is the perfect and frequent scouring of the body itself. Washing and friction of the skin, too, open the minute orifices of the ducts which carry the secretions to the surface, thus aiding their free discharge and the proper function of the glands. A cold bath, again, by its action on the sensory nerve-fibrils, tends to brace up and make more stable, not only these surface branches, but the whole nervous system, just as a warm bath tends to soothe and relax it.

Rules for Washing and Bathing Children.—Little children will not bear the rough treatment of the surface by extremes of heat and cold, which may be used with impunity, or even with advantage, in the case of full-grown people. The temperature of a child ranges slightly higher than that of an adult, but its special characteristic is its mobility. It is easily disturbed by slight causes. Mental excitement or emotion, brisk exercise, warm clothing, a hot room—which would not be sufficient to affect a grown person—will send up the temperature of a child a degree or more; while the depressing causes of fatigue, want of food, exposure to cold, will lower it in a corresponding manner. The temperature of a little child is easily raised and readily depressed, and does not soon regain the natural standard. The heat-regulating apparatus of the body works less perfectly than in adults, and it is necessary, therefore, to use the agents which affect the natural body-heat—such as baths—more gently and carefully. A young infant in the first few weeks of life should be washed in a good-sized bath (not a basin) with warm water—that is, water of a temperature of from 92° to 95°. The child should be placed in gently and quietly, so as not to frighten it. At first it may be lowered in on a bath-towel, and only just covered by the water; but as it becomes accustomed to the operation of washing, the towel may be dispensed with, and it may be gradually immersed up to the neck. The body should be gently rubbed with a soft Turkey sponge and some of the finest soap—common soaps of all kinds contain much free caustic alkali, which is irritating and apt to make the skin inflamed and sore, but there are a number of fine toilet soaps, any of which will do perfectly well. The lather should be thoroughly rinsed away with a full stream of water from the sponge; this is quicker, more effectual, and less chilling than a small trickling flow. The child should then be dried gently and rapidly, but very thoroughly, with a fine linen towel; and all parts where friction is possible, or where moisture is liable to appear, should be freely dusted with pure prepared starch, or prepared fullers' earth powder. Thorough drying and free dusting are essential to the preservation of the infant's delicate skin from rashes and excoriations. The whole operation should be rapidly carried on behind a screen and before the fire. Wet clothing should be instantly removed, and the wetted parts of the skin sponged, dried, and dusted. As the child grows older, the heat of the bath-water may be reduced, until at three months, if the season be summer, the weather warm, and the child strong and healthy, the temperature need not exceed 70° to 80°—*i.e.*, the bath is made tepid. In winter, however, or in inclement weather in summer, this reduction should be postponed, and the warm bath continued at a slightly reduced temperature (about 85°), until the child is six months old. In the case of very feeble delicate children, those born prematurely, or of fragile constitutions, the cooling of the bath must be put off still later, and carried out with even greater caution. At six months, if the child be strong and well, the morning bath may be modified by free sponging with cool water, at a temperature of about 65° to 70°. If the season is hot, absolutely cold water may be used for a robust child; but the effect should be well watched. A cold bath should not be allowed if it is seen to leave any sign of chilliness or blueness of surface. In some individuals the glow of reaction is very imperfect, and lips, hands, and feet remain livid and icy-cold long afterwards. For these the cold water should be postponed till they are eighteen months old or more.

Cautions with regard to Cold Baths.—The best plan of giving the cold bath to little children is to place them in a bath containing warm water, wash them in that, and then at the finish sponge them for a moment with cold water. With older children warm water should be placed in the bath for them to stand or sit in, and cold water dashed freely over them with a large sponge from a basin standing ready at the side. By this means the subsequent coldness and discomfort are avoided, the feet immersed in hot water are kept comfortably warm, and the full tonic effect of a cold affusion is gained without its disadvantages. In hot summer weather the warm water may be omitted, and an ordinary cold bath given; but in winter, and, indeed, in cold weather at any time, hot water to stand in should be the rule in the nursery.

A cold bath thus judiciously administered is of immense service to adults, but to children, with their mobile surface, circulation, and temperature, it is especially valuable. It practises the skin, so to speak, in the operation of regulating the blood and heat supply according to circumstances, and this repeated practice renders it apt to meet emergencies affecting the surface heat and circulation, such as cold draughts, damp air, hot rooms, scorching sun; and moreover the daily repetition of the process makes the nerves and vessels less sensitive. They are less affected by cold when the cold comes with frequent regularity than when it is a novelty—a strange and unusual accident. Great care should be taken not to frighten children by severe shocks, such as a shower-bath, or plunging them into the deep water of baths or into the sea. Much cruelty is unintentionally practised in this way, with the view of accustoming the child at once to the plunge overhead, or to overcome what seems unreasonable fear or obstinacy in objecting to it. A dread of water is frequently established in this way which is ineradicable, and proves a serious drawback to comfort and safety in after-life.

If the child is delicate, and a cold bath, even on the modified plan described above, proves too severe, tepid salt water may be substituted for it. Salt stimulates the skin, and sets up a responsive glow, much as cold water does; and as it can be given with warm water, the glow is obtained, while the refrigerating effect is avoided.

By this means many individuals excessively sensitive to changes of temperature and atmosphere, who take cold on the slightest exposure, and live in an almost perpetual state of catarrh, are enabled to attain a fair degree of hardness, and find an escape from the risk and annoyance of recurring illness of this kind.

The practice of taking warm baths, which is very customary with sensitive persons, makes matters worse by increasing that very instability and over-sensibility which is the root of the evil.

Children should take the cold or tepid both in the morning, when the body emerges warm out of bed, with full heat, and able to bear the cold shock best; and it should be given without delay, before the body is cooled by exposure, and a good fire should be kept to dress them by afterwards. Playing about the nursery in night-dress or dressing-gown should never be allowed before the morning bath is given—since this cools the body and extremities, and renders them less able to resist cold and react against it. At night sponging with warm water, or washing with soap and water if necessary, will be sufficient.

Another important point with regard to the bathing of children is that they should be thoroughly and completely dried afterwards. Not only is the friction of the skin for some time essential to the ready production and permanence of the reactive glow, but the perfect drying of the surface is necessary to prevent chapping and excoriations. Neglect of this rule is a fruitful source of small childish miseries. Cold hands and feet, chilblains, a sense of chilly discomfort for hours afterwards, are amongst the common results of dismissing the child from its bath only half rubbed down. One cause of this hasty and imperfect work is pressure of time. The nurse gets up rather late perhaps, or the child stops playing in bed instead of rising promptly; the breakfast bell is expected every moment; other children are waiting their turn to be dressed; school-time approaches; and so the unhappy children are passed on as rapidly as may be, dressed while their skins are still damp and cold, before the glow of reaction has been established. The natural impatience of children, and their dislike to the operation of prolonged rubbing, favour this evil practice, and thus they enter upon the day with depressed circulation, chilled blood, and a legacy of chapped, aching, tender fingers and toes, to last them for weeks to come.

The lesson of perfect cleanliness of the body is an important one to impress upon the child. We have seen how essential it is to the preservation of health, and observance of it in the smallest details should be rigidly enforced in the nursery.

Every fold and crease and recess should be as carefully kept free from dirt as the more accessible parts. Child as well as nurse should be taught that feet and toes and hands and fingers should be kept as clean and dainty as face and ears, and that any defect in this is a reflection on decency.

Development—its Stages and Disorders.

During the period of development, which extends over a space of twenty-five to thirty years, certain definite and important changes in the bodily structure and powers are accomplished. At birth the child enters upon a new phase, with a body still imperfectly organised, and as yet unable to sustain a separate existence without external aid. But this stage is transitional; the bodily structure progresses steadily towards a more perfect form, and to increased power, completeness, and independence. The process goes on until about the thirtieth year, when it is finally completed by the ossification, or final transformation into bone, of the sacrum—the lower portion of the spine. This long term of progressive development is marked by several stages. These are defined with more or less accuracy by the occurrence of certain characteristic features, such as the evolution of the two sets of teeth, the change from childhood to adolescence, and the attainment of full form and stature.

The first of these successive stages coincides pretty closely with the first two years of life. During this period the temporary or milk teeth push through the gums; the skeleton, largely cartilaginous at birth, advances into the more perfect structure—bone. The muscles, and the nervous apparatus which controls them, increase in power and scope; the child learns to balance its body in the erect posture, to stand and walk, and to utter articulate sounds. The intellectual faculties developing together with this increased muscular power and dexterity, the child begins to associate ideas with sounds, and expresses them in words.

The time and order of the changes evolved during this first period of the first two years of life afford useful landmarks by which to estimate the progress of growth and development, and deserve a more exact statement.

Weight and Height at Different Periods.—First, with regard to the simple matter of height and weight. Mothers are constantly exercised in mind as to whether their children are growing as they should do, and whether they are fairly up to the standard size. There is, of course, a very considerable variation in this respect. Even new-born babies differ widely in build, and bulk, and form. Children are made on different models, and on different plans—some on a larger, some on a smaller scale from the first. They start in life, not only with an individual peculiarity of bodily structure and strength, but one of varying capacity for growth and development. Yet there is no necessary relation between size and robustness. A comparatively small child may be extremely strong and full of vitality, a large one soft and feeble. As a rule, no doubt, a very small infant is usually delicate and fragile also; but as an indication of health and vigour, firmness of flesh and bone, with a steady increase of bulk and weight, are of far more importance than gross high ponderosity and stature.

At birth a boy should weigh some 6½ to 7 lbs.; a girl somewhat less, or about 6 to 6½ lbs. These represent fair average weights, but the range for a healthy child is between 5 and 8 lbs. Yet children have been born apparently healthy, and have lived, and grown up into strong men and women, who weighed much less than this when they entered the world. They have been noted as light as 4 lbs., and on the other hand again as heavy as 12 lbs. Twins, again, are always of lower average weight and size than single children, although the two together weigh more than any single baby.

In height a boy should measure at birth on an average 18 to 19 inches; a girl some half an inch less—the range of health lying between 16 and 22 inches.

The child grows with rapidity during the first year—faster than during any other period of the same length; so that it gains about 8 inches, measuring, when twelve months old, about 27 inches, its weight being about 19 lbs. During the second year it gains only 4 inches on an average, and 5 lbs. in weight, reaching a stature of 31 inches, and a weight of 24 lbs. But these figures represent only the average, the extremes ranging between wide limits.

With regard to weight and plumpness, it should be remembered that during the second year, when children learn to walk and run about, they naturally become thinner; their incessant restless activity requires for the production of force exerted a large amount of fuel-food, and it is used to a greater extent in this way, instead of being stored up as fat, as it is during the inactive period of earlier infancy.

Children, again, may be extremely fat, and yet deficient in solid bone and muscle. One of the prize children of the first baby show was brought to me suffering from rickets, fat, flabby, and cartilaginous. Yet there is no harm in the fat in itself; many healthy children are strikingly so before they begin to run about, especially if fed on food which contains a large proportion of sugar, as Swiss milk, for example. It is the want of colour, and hardness and firmness of flesh in addition, which is unsatisfactory, as seen in soft white children fed on artificial farinaceous food.

Period of Walking and Talking.—As a rule, children of average development begin to walk from the twelfth to the eighteenth month. Those who learn to crawl often find this mode of locomotion sufficient, and will not trouble to learn to walk until two years old or more. Large heavy children, especially if at all rickety, should not be encouraged to walk before eighteen or twenty months old. With regard to talking, also, there is great variation. The baby usually begins to lisp a word or two soon after the end of the first year; but if a child has learnt the art of pantomimic gesture to express its wants, it may be two years old or more before it will take the trouble to use articulate speech.

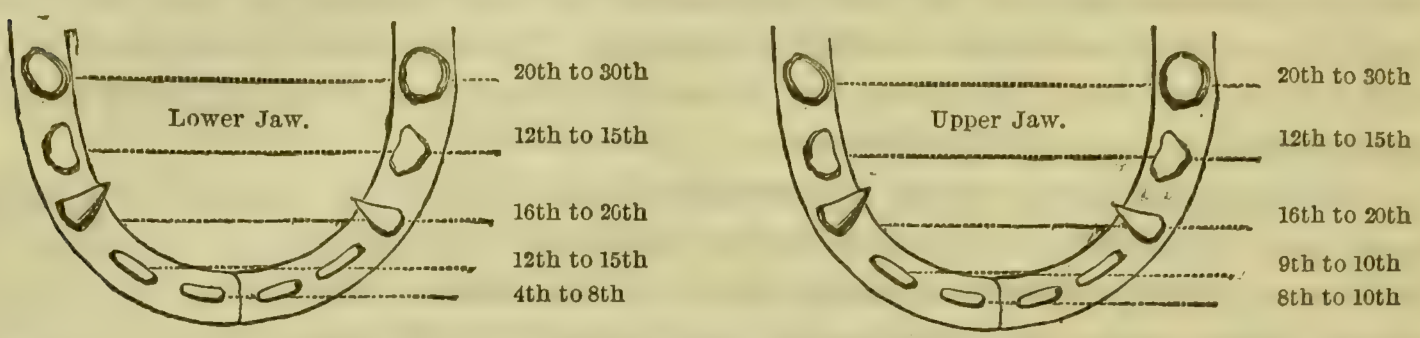
Standard Signs of Development of Bone.—One of the standard signs of the progress of bone development is the condition of the anterior fontanelle—the so-called "soft place" in the head, well known to mothers and nurses. It is situated on the top of the skull, about one-third of the way between the forehead and the crown. The fontanelle represents a space between the bones at the point where they approach together, which is bridged over by membrane at birth, and is gradually obliterated by extension of bony formation as growth proceeds. At first it is of irregular quadrangular form, in area perhaps equal to a florin. At six months this should be reduced to the size of a shilling or thereabouts. At the end of the first year the membranous portion should not be larger than sixpence, and it thenceforth rapidly decreases; so that from the twentieth to the twenty-fourth month, if bone formation proceeds naturally, the opening should be no longer appreciable to the touch, although the actual joining of the bones is not finally completed until much later, viz., about the fifth year. This closure of the fontanelle at the end of the second year affords a fair test by which to judge whether the development of the bone is proceeding regularly according to the standard rule.

The condition of the long bones—*i.e.*, the ribs—and the bones of the arms and legs is a matter for observation also. If they remain too soft and cartilaginous, they bend and give way under the pressure to which they are exposed; as the ribs under the pressure of the atmosphere in drawing in the breath, and the bones of the legs and arms in supporting the body in standing or creeping. The giving way of the ribs causes the chest to assume the form of the "pigeon-breast," from the falling in of the sides, and the pushing forward of the front or breast-bone; in slight cases this may amount to nothing more than a small depression underneath the nipples. The legs or the arms, yielding under the weight of the body, become bowed; the wrists become enlarged; sometimes the child grows knock-kneed, or its ankles give way, owing to the relaxed condition of the ligaments. This condition of imperfect formation of the bony structures is only one part of a general constitutional defect of development, which affects flesh and nerve structures as well as bones and teeth. When it exists, the child is flabby and feeble of muscle, and backward in every way; it sweats about the head to such an extent as to moisten the pillow as it sleeps at night—has a tendency to croup, bronchitis, diarrhœa, and convulsions. Such dire results occur only in certain cases, but yet it will be well to note the signs of the first appearance of this tendency, so that the child may at once be placed under medical treatment. The condition of rickets is in the vast majority of cases due to a simple defect of feeding, and can be cured quickly and certainly by appropriate measures.

The Time and Order of the Appearance of the Teeth.—The process of teething is always a matter of interest in the nursery; the question of whether the teeth are coming affords constant food for discussion; the advent of each is viewed with pride and satisfaction, and there is good reason for this. The appearance of the teeth in due time and order of succession is of importance, for it affords evidence of the regularity of the general advance in growth and development and the rate at which it is proceeding; and is a proof, therefore, of the sustained health and vigour of the child.

The first set of teeth—the temporary or milk teeth as they are called—which are twenty in number, commence to push forward about the time of birth, but do not, however, usually actually emerge through the gums until some months afterwards. The first in natural order are the two middle front teeth, or central incisors, of the lower jaw; they appear from the fourth to the eighth month, most commonly towards the end of this period, or about the sixth or seventh month. There is then usually a pause of from three to nine weeks before the two corresponding front teeth of the upper jaw come through, about the eighth to the tenth month. These are generally followed almost immediately by the two other front teeth of the same jaw—the upper lateral incisors—one on each side of the first pair. After this there is usually another pause of from six to twelve weeks before the remaining two front teeth—the lower lateral incisors—which now come through, one on each side of the first lower pair, about the twelfth to the fifteenth month. Almost coincidently with these—*i.e.*, also from the twelfth to the fifteenth month—appear the first four double or molar teeth. Indeed, it constantly happens that the two first molars of the *upper* jaw appear before the second pair of front teeth, or incisors, of the *lower* jaw. Then follow the first molars, or front double teeth of the lower jaw. After this there is once more a pause of two or three months before the most important event of this first dentition—the cutting of the canine, or eye-teeth—takes place, which should come through from the sixteenth to the twentieth month. Then another period of rest supervenes, until finally, from the twentieth to the thirtieth month, the last four double teeth appear and complete the tale.

This regular order of time and evolution is subject to variation. There are well-authenticated instances of children being born with teeth. Mirabeau came into the world with two teeth, as well as with a club-foot and tied tongue, and Richard III. and Louis XIV. are credited by tradition with a like precocious development. On the other hand, dentition is more often unduly delayed. Dr. Churchill gives a number of instances of the kind collected from various sources, more or less reliable, the most remarkable of which are that of a boy who did not cut his first teeth until the age of seven years; another who at six had only ten front teeth; and a third who did not get his eye-teeth until he was thirteen. All such extreme cases are, however, entirely exceptional and rare. But still, variations within certain limits are sufficiently common, some natural and unimportant, some dependent upon faults of constitution or of nurture. Occasionally the first teeth appear within the first few weeks, or are delayed to the ninth or tenth months, or do not appear in pairs, or not in the strict order of succession. These irregularities, however, may be consistent with health—vagaries of Nature of no serious import. It may be said generally that robust and healthy children, properly fed and nurtured, as a rule cut their teeth about the normal period, earlier rather than later.



DIAGRAMS SHOWING THE FIRST SET OF TEETH, WITH THE USUAL TIME AND ORDER OF THEIR APPEARANCE.
The figures indicate the date in months.

The cross-cutting of teeth, as it is called, or cutting them out of due order of succession, or not in pairs, is of little importance, unless it is associated with late development.

The appearance of the teeth earlier than usual has in itself little significance. It may occur in healthy children, but is most common, perhaps, in children who are fragile and precocious—one sign only out of many of a tendency to ripen early, the result of an original constitutional peculiarity. Delay in the appearance of the teeth, on the other hand, like retarded closure of the fontanelle, is suggestive of the backwardness in bone formation, described before, a defect usually due to wrong feeding, capable of arrest and cure, although fruitful in trouble if not removed. This condition may be present in any degree, from extreme contraction of chest and distortion of limb, to a yielding of softened bone so slight as to be capable of detection only by an expert. Late teething is often one of the earliest indications of this minor form, and children affected in this way frequently do not begin to cut their teeth until twelve months old, and, in extreme cases, as late as the end of the second year. This is of importance, too, not only as a sign of the state of defective nutrition generally, but also because the teeth evolved thus late make their way with difficulty, are liable to excite serious distress and disorder in the process, are fragile, moreover, and decay almost as soon as they appear.

If, then, a child reaches the age of ten or twelve months without any appearance of teeth, or if, although the first came in due time, the succeeding groups fail to follow within reasonable space afterwards, according to the data given, it will be well to consider whether there is any special cause for this. Examine whether there are other signs of backward development. Consider whether the child gets a sufficient amount of milk, or of nitrogenous matter and fat in some form or other, or is fed too largely on farinaceous food; whether it is supplied freely with fresh air, and lives amidst wholesome sanitary conditions. It may be that all is well, the alarm a false one, and the delay in dentition due to a natural slowness of development. But the chances are there is some outside cause for it, which can be remedied, and a long train of future troubles thus satisfactorily averted.

Ailments Associated with Teething.—All the ailments attributed to teething cannot really be ascribed to this cause, or to this cause alone. There can be no doubt, however, that the forcible passage of teeth through the gums, making their way by actual pressure upon the parts, is a source of irritation, which affects different parts of the economy in various ways, more particularly the nervous system, the mucous membrane, and the skin. Signs of this appear in restlessness, fits of crying, disturbed sleep, night terrors, in some cases convulsions, bronchial catarrh, diarrhœa, eruptions.

Yet these are by no means invariable or necessary accompaniments. When dentition proceeds favourably, the pain and general irritation are usually very slight. The discomfort is chiefly local, from the pressure of the advancing tooth against the fibrous capsule which encloses it, and on the gum above. These are gradually absorbed, and the tooth passes through. The pressure causes the gums to become swollen, the irritation excites the flow of saliva, so that the child dribbles from the mouth, puts everything it can get hold of into it, and bites to relieve the sense of discomfort there. As the teeth advance further, the gums become sore and red, perhaps hot and inflamed; the child starts with sudden twinges of pain, becomes fretful, restless, sleeps less quietly, and has, perhaps, slight looseness of the bowels, and a rash on the skin. These all pass away when the tooth comes fairly through. In some cases, a dribbling mouth and a few restless nights form the sum of the infant's troubles; and the whole process is completed without nurse or mother having a moment's anxiety on account of it.

And this is matter for congratulation on other grounds than that of the mere escape from worry and distress at the time. Easy teething is one of the most valuable and reliable signs of soundness of general health and vigour of constitution, since a robust and healthy child rarely suffers much from teething. Occasionally, very large eye or double teeth cause serious disturbance in making their way through, but this is a comparatively rare exception to the general rule. As previously stated, the children who suffer most are those of naturally sensitive, excitable, nervous organisation, and those suffering from rickets.

The latter are liable, above all others, to the disorders accompanying dentition. A most unstable nervous system and irritable mucous membrane being a part of their defective bodily state, they are especially subject to bronchitis, diarrhœa, laryngismus, and spasmodic and convulsive seizures at this critical period of disturbance.

These ailments arise chiefly during the latter part of the period of dentition. It is the eye-teeth and the double-teeth which give trouble. The pushing incisors seldom excite serious irritation, except in extremely sensitive backward infants. They are often discovered suddenly, having made their way through without giving any previous sign of their approach.

THE GENERAL MANAGEMENT OF CHILDISH DISORDERS.

In conclusion, a few words of warning with regard to the management of childish disorders may be added without unduly trenching upon medical treatment.

First, it may be laid down generally that the household medicines given to little children should be strictly limited to simples, such as magnesia, a little aromatic chalk powder, and sal-volatile, for the immediate relief of flatulence and diarrhœa, and an occasional dose of castor-oil. Children should be trained to take medicines voluntarily, without forcing or "drenching," as it is called. This can always be done by avoiding drugs of disagreeable taste, and the aid of patience and kindness.

A special caution must be given with regard to the occurrence of diarrhœa, for very mistaken notions are prevalent on this subject. A belief exists very generally amongst mothers and nurses that a little diarrhœa is an excellent thing during teething—a safety-valve and preventive of convulsions. This is a popular fallacy. That the bowels should be sufficiently open is a good thing, and there is no harm in their being very slightly relaxed; but anything more than this is a source of danger to a little child, which can ill endure the drain of purging. Diarrhœa, even if slight, should be checked without delay, and kept carefully under control. It is liable to run to a degree which may become absolutely uncontrollable, and to set up that very state of convulsion against which it is erroneously supposed to guard.

Therefore, if looseness of the bowels arises during teething, or at any other period, seek medical advice as to its regulation forthwith.

With regard to the opposite condition of constipation, which, although not dependent on teething, is often most troublesome in early childhood, the danger lies rather in the other direction—of a too active interference by the administration of household remedies. Repeated dosing with rhubarb and senna, Gregory's powder or castor-oil, or the regular use of enemata, aggravate the condition in the end. The frequent giving of nauseous drugs, such as rhubarb, senna, Gregory's powder, too, disgusts the child with all medicines, and it refuses to swallow any without a struggle—a serious drawback afterwards when medicine is necessary for the treatment of a dangerous disease. The only laxative admissible in the home management of such cases is the simplest saline medicine, fluid magnesia or carbonate of magnesia. Permanent cure of a constantly confined condition of the bowels, not unfrequent in hearty milk-fed children, can be effected only by a wise regimen, and treatment systematically carried out under medical advice.

A form of nervous attack, which is a common cause of anxiety and alarm, is what is called night-screaming or night terrors. The child wakes up suddenly during the night, screaming violently and persistently, looks wild and terrified, refusing to be pacified, seemingly only half-conscious, and not understanding what is said to it, or noticing the nurse or mother who is with it. After a time, it may be an hour or two, it quiets down, and goes off to sleep again. The explanation of this appears to be that, owing to the irritation of teething or some other source of disturbance, the child dreams of something terrifying, and wakes up in an agony of distress and fear. When such an attack occurs there is some cause of irritation at the bottom of it, and medical advice on the point should be obtained.

The slighter nervous ailments, restlessness, crying, disturbed sleep, are likewise signs of the existence of bodily discomfort of some kind. Children who are well are comfortable; these symptoms show they are not so, and if habitual, are proof that all is not quite right, and the cause of disturbance should be inquired into. It may be aching tender gums, or uncomfortable clothing, or flatulence, or nervous irritability from some other trouble of greater importance. Such ailments must not be glossed over and lulled by soothing syrups and elixirs. Narcotics may effect their object at the time, but they are dangerous, and infallibly lead in the end to serious impairment of health. If the disorder is such as to require remedy, the case should be referred to a doctor.

In these days instances of the surreptitious use of soothing syrups by nurses of the better class are rare, although the practice is still prevalent amongst the poor. In a young child the occurrence of constant drowsiness so that it hardly wakes to take food, constipation, and a contracted state of the pupils of the eyes (signs of the effect of opium in some form), should, however, rouse suspicion of drugging of this kind.

It must be remembered that children vary immensely in the amount of sleep they take, and in the time at which they take it. Some sleep placidly during the greater part of the intervals between feeding times for the first few months of life, and spend a peaceful and untroubled existence. Others, again, seem to have a perverse habit of sleeping during the day, and lying wakeful during the night, happy and content so long as amused, but resenting by pitiless crying all attempts to coax them to be laid in cot and put to sleep. For this there is no remedy but time and patience. Usually, however, restlessness is due to bodily discomfort of some kind, and the cause of it should be inquired into and removed.

Lastly, with regard to vaccination. This should be done within the regulation time of three months if possible. Children bear it more easily before the period of teething disturbance sets in, and to leave it until this has passed is to expose the infant to terrible risk.

An attack of small-pox is almost certain death to a young child; the proof that vaccination affords certain protection from such fatality is absolute and complete; the evidence on this point afforded by small-pox hospitals is conclusive. Successful vaccination confers absolute immunity from death by small-pox for many years to come; in the vast majority of cases it protects from the disease altogether—in all from the disease in any but its modified and milder form. The existence of any serious affection of another kind is of course a sufficient reason for postponing the operation, but no slight skin eruption or trivial ailment, such as is often deemed an adequate reason for delay, should be allowed to stand in the way.

By those who note only occasional coincidences, and found an opinion upon the most limited experience, vaccination is credited with being the cause of skin eruptions, and of worse evils still. No one who has had experience of children's diseases on a large scale can accept this as true for a moment. Although I have been constantly on the watch for an accident of the kind during the last twenty years, out of many thousands of children who have come under my observation, I have not met with one suffering from any form of serious disease which could be attributed to vaccination, with the exception of one or two instances of abscess, due to the use of over-ripe lymph. The cases of such transmission of disease on record altogether are extremely few. The possible evil from vaccination is in any case most remote—with ordinary care and skill absolutely nothing; the good is undeniable and immense.

Lymph from the calf or from a known healthy child answers the purpose equally well. The most nervous and anxious mother may trust her child to be vaccinated by a responsible practitioner with perfect confidence, assured that with reasonable care no ill results can arise from the operation, while safety from one of the great scourges of human kind will infallibly be secured by it.

HEALTH AT SCHOOL.

By Clement Dukes, M.D., B.S.,

Physician to Rugby School and to Rugby Hospital.

Introductory—School Health—Choice of a School—Choice of a Master—Choice of a Boarding-house—Education before Entering School—Sanitary Education—Entering School - Medical Examination—The Master's Boarding-house—Studies—Sleep—Dormitories—Meals—Sanitary Arrangements—School—The Chapel—Class-rooms—Over-work—School Government—Punishments—Play—Physical Education—Illness—Sick-houses—Epidemics and their Prevention—Infection—Self-regulation of Health—Day Scholars—Girls' Schools—Conclusion.

Introductory.

Like many accepted truths, the unity of man's nature, and the consequent intimate relation between his physical condition and his intellectual and moral efficiency, had long endured the fate of lying bed-ridden, as Coleridge expresses it, in "the dormitory of the soul, side by side with the most exploded errors"—as little operative as though it formed a member of the latter class.

This truth, however, is now being rescued from such companionship, and attempts are at last being made in various directions to render it practically vital. It will be admitted that at no stage is it more imperative to give effective recognition to it than during the period when both the physical state is in process of natural development, and the mental powers are at the same time, by every method known to able and experienced teachers, being brought into active play and power. A false step here—a want of concurrent development between the mind and the physical basis with which it is connected—may seriously affect the whole of the future life, and the efficiency of the boy as a worker in the world. It is accordingly a feature of great encouragement to those of us who have to direct the care of health that, following the example set by recent masters and teachers of sound sense and knowledge of human nature, the teachers of the present day are generally willing and eager to receive and execute the teachings of sanitary science—knowing that *their* work is aided and improved by the work which that science takes in charge. Education happily has ceased (or, at all events, is ceasing) to be the mere cramming of facts into pupils' minds, to the consequent over-development of memory, and the neglect of the active powers of mind; and it is now recognised that it must not simply store brains, but educe faculties, and, simultaneously, that the physical powers and functions require also a genuine education of their own.

How far this encouraging change is due to the enlarged study of natural science, now so prevalent in our schools, and the tone of thought and observation which it produces, it is not within my province to inquire. The introduction of that study has, no doubt, borne its share in the change; while the principles with which it has made parents, boys, and masters familiar will render easier their perception of the principles of sanitary science, and increase their ability to apply them.

The time, therefore, seems to be ripe for some adequate and simple guide to the application of the principles of hygiene to school life; and my object in the following pages is consequently not simply to describe the general principles of health, but to treat of them in their relation to the circumstances of life at school, and, as far as possible, to lay down precise and clear rules by which, to an adequate extent, the masters and the boys themselves may be readily guided.

I shall speak largely of the scheme that should be adopted in "public schools," regarding not merely the individual health, but also the entire surroundings of the boy: his play; his time, amount and mode of work; the sanitary conditions requisite in the school-room, the study and the boarding-house; his meals; and his general course of life while under school control, together with the relations, in respect of health, between the life at home and at school.

It is obvious, however, that my remarks will equally apply, allowance being made for purely local arrangements, to private schools, whether for boys or girls.

The relation between home and school, in respect of health, is of the most intimate character, for the best supervision at school can only work upon the raw material, so to speak, which the home supplies.

The most elaborate sanitary appliances at school, and the most carefully constructed scheme of life, cannot rebuild the imperfect constitution—so frequently brought from home by the boy—produced or fostered by sanitary defects and neglect of the rules of health. I, therefore, indulge the hope that such methods and rules laid down hereafter as may be applicable to home life (for though here regarded in relation to school, they necessarily possess the widest range) will gradually be adopted, until the boys furnished to our schools shall be, as far as healthy conditions and personal parental attention can secure it, strong, manly fellows, who shall complete that happy transformation of our schools throughout Great Britain which for years past has been continuously taking place.

I am also hopeful that this result will be aided by the inculcation upon boys of simple personal rules of health, to which I shall refer later on; not only because their intelligent concurrence in some of the methods adopted to secure the fullest health to them is needed, but also that they, in their future capacity as parents themselves, may intelligently and more zealously devote themselves to the work of providing and maintaining, wherever their influence extends, that sound body in which they are to develop a sound mind.

I shall conclude with a few remarks upon the proper training of girls during their school life: a most important subject, looking to their destiny as the mothers of the future, and the need of their transmitting a hardy and healthy race. Unfortunately, this subject is not only too often overlooked, so that the physical education of girls is wholly neglected, but some of the prevailing methods of female education—among which I would specify the excessive competition in examinations which is now so rife among girls—are absolutely fatal to a healthy girlhood. I add one word, and one only, upon the moral considerations which enter into all systems of hygiene. The teaching at home in respect of self-reliance, patience, purity, truth, and endurance, followed by the vigilant development of these virtues in the little world of school, while ennobling the whole nature, aid essentially also in securing that simple strength and vigour of bodily frame which will more and more fit it to become the worthy companion and servant to the soul.

School Health.

For this, all the conditions of the pupils should be so regulated and under control as to ensure, amongst a number, a maximum of health. For while an individual pupil may live under obviously unhealthy conditions, and not apparently suffer, yet if a number were congregated together under similar conditions, illness would immediately arise; so that, while in a large school it is the number that should be considered, yet in carrying out this rule the individual pupil is far better provided for than he would be otherwise: for a number can only remain healthy when their surrounding circumstances are in the highest state of efficiency.

Ill-health amongst a number means that there is a grave fault somewhere: a fault in which a number *cannot* live is a fault in which the individual *should not* live.

Under healthy conditions alone can the greatest amount of work be obtained from, and the most favourable chances for growth and development be ensured to, the individual during the period of adolescence.

School health can alone exist under such a mode of life as shall tend to produce a sound mind in a sound body, and not a well-crammed head on a stunted body. Therefore, I shall have to speak of the pupils' mental and moral training in considering school health; for the health of the body is influenced to a great extent by the mental and moral education of the pupil, and no amount of school health can exist at all without the harmonious culture of the mental, moral, and physical conditions of the pupil.

That very large schools—especially under the public school system—are a feature of English school life is beyond question. That this is the best system is, I think, beyond a doubt. But while I advocate these large public schools (which are continually on the increase), I am sure that they should be split up into various boarding-houses or sections, for each can then be better managed, and if infectious illness should arise it is less likely to become epidemic than if all, or most, of the pupils are congregated in one house.

These boarding-houses should neither be large nor small—from thirty-five to fifty are the best numbers: a less number being unlikely to induce a first-rate master to undertake the responsibility of a house, or, having undertaken, to retain it.

Choice of a School.—Many points should enter into the parent's consideration of a question so important; and if I were to lay stress anywhere, it would be on the choice of the boy's *first* school, for not only his health but his character often depends on the character of his first school; and yet the parent frequently deems this school of no importance, and thinks only of the public school that is to come after.

Moreover, in the choice of a school for his son, a parent should not deem this a sufficient reason, that "I was there, and my father before me, and my grandfather," forgetting that all institutions change as time goes on, and that there are other reasons besides ancestry in schools which should determine the choice. A great wrong may be done to a boy, and his whole life blighted, by a mistake here.

And first, I think, the boy himself should be considered as regards his *health* —whether the school be rightly situated sanitarily—for often the situation may be prejudicial to a boy, and instead of his developing into a strong, healthy man, through being placed in healthy circumstances during the years of active growth, the reverse may happen. There may be developed or fostered an hereditary weakness in his constitution which, under more favourable circumstances, might have been checked, and perhaps even eradicated.

Thus, a boy with a *rheumatic* constitution should on no account be sent to a school situated on clay, and with a humid atmosphere, where perhaps one boy in every thirty suffers from rheumatism during his residence. A boy from a *phthisical* stock should not be placed at a damp, low-lying school, however famous in name and character, and however many ancestors may have honoured it. A boy with a *feeble circulation*, showing chilblains on hands and feet on the slightest provocation, should not be placed at school in a cold, bleak situation during his years of growth; his residence should be high and dry, on gravel, and with a climate as genial as may be found. A boy with a *neuralgic* predisposition should not be sent to a bleak, windy, exposed place for his education, for he will be always suffering from neuralgia in head, face, or ears. A boy with hereditary predisposition to *kidney disease* might be saved from its development by being educated only at the warmest and driest place, and the one least exposed to the cold winds of spring. A boy from India, especially if he have suffered from malaria, requires a dry and warm place during his growing years, and should enter his school only at the most favourable time of the year for fine and warm weather. The best situation for a school is at the top of a hill, facing south, and having the soil of gravel, sand, or chalk; and if it can be so placed that it can be protected from the north and east by trees, especially pine-trees, so much the better as a health resort for all boys during their growing years. Such a situation for a school is of incalculable value to every boy, though chiefly to the delicate ones.

The next question to consider is the *capability* of a boy, so that he may be educated most thoroughly. It is unwise to send a boy who has no taste for, and who cannot master, classics to a purely classical school. It frets a boy, and may make him miserable and ill to find that he is losing caste at school; and this result will be aggravated by the consciousness that he has ability which, in other subjects—mathematics or science—would secure him distinction. I do not wish to imply that a boy who has no taste for languages should on that account be exempt from the trouble of learning them. Far from it. I would have every boy educated thoroughly all round, and I would try to encourage a taste and a liking where none, or the reverse, existed. But what I mean is this : in a classical school, a boy who is a good classic is everything; but a boy who is not a classic (and whom nothing can make into one), although he may be a perfect genius in science and mathematics, is nowhere. Were such a boy placed in a suitable school, he would be one of the leaders, and his pride and pleasure would make and keep him a leader. Yet, being improperly placed, he is unhinged, and feels cowed because of his inability successfully to compete with his school-fellows, in spite of his talents in other directions.

It seems to me that schools consider the *real* education of a boy far too little, forgetting that a boy is sent to school to learn to prepare himself for his contact with the world as a reasonable being, and not simply as a skilled classical scholar, and perhaps nothing else. It may be an essential part of a boy's school training that he be taught to master thoroughly something difficult, and necessitating great labour to attain it; but this training may surely be found in science as well as in classics. I think the importance of learning the dead languages, as a training for young minds, is very much exaggerated, and I fail to see their superiority to mathematics, science, and the modern languages, which latter are far more useful to the average boy on entering the world.

Where a boy has a taste, let it be encouraged by every legitimate means, without making him one-sided; send him to a school where he can most perfectly develop, mentally as well as physically. Let his *mental* bread and meat be what he cares for, and he will eat plenty of it, and not mince at it, as he will at work that is distasteful to him; he will then thrive and be a credit to you : a good worker, because he likes his work; self-reliant, because he finds he can master what he has to do; a good honest boy, because he is employed at work which he likes, and so has no spare time for even thinking of evil. Give him work not congenial to him, and you will find him mope and be out of health; dissatisfied with himself, his master, and his school; no credit to himself or his parents; an idler, with the terrible consequences of idleness.

Choice of a Master.—Under whose care and supervision a boy is to be placed while at school is a matter of no small importance, for there are masters and masters; and while all may be equally able men as scholars and teachers, and all equally high in character, yet all are not equally good in the management of boys. Above all, avoid a master lax in his discipline.

In a private school, the master who conducts it is everything : he is monarch of all he surveys. In a public school, a house-master, under whose care a boy is placed, is also everything to a boy, and has absolute control over him during his residence in his house. It is this autocracy of a house-master which gives a boarding-house a character in a school, and almost irrespective of the school : so marked often that a boy bears the stamp of his boarding-house all through life; hence the boarding-house and boarding-house-master are a distinct element for good or evil.

And while house-masters thus differ, so their houses differ *sanitarily;* one master will seek out and effect every improvement for his house, while another can only be moved by a great crisis which renders changes imperative. So it is with masters of private schools as well.

Moreover, boys in one house meet boys from other houses in form and in chapel, but for the rest of their time they are isolated, as a rule; they usually play together as houses, and not as a school, and a boy in one house, as a rule, does not visit at another house: though in some schools this does take place among the elder boys. It will thus be seen that one house may differ very considerably from the rest, and while the tone of the school may be good, the tone of a house may be bad; or, while the tone of a house may be all that could be desired, that of the school itself may be far different from what could be wished.

It must be remembered that our great schools, as a rule, are officered by some of the very ablest in the land—men whose peers it is hard to find. Such schools require such masters. And a parent needs a master who will take his place, and be able to instil confidence in the boy; then that mutual regard will exist which generates not only respect but affection. Some of the best life-long friendships have been, and are continually being, formed between a boy and his master. It was eminently the case with Thomas Arnold—whose spirit, I am thankful to say, still pervades all our schools more or less—the friendship of whose pupils lives in English literature. It was also the case with James A. Garfield, the teacher, afterwards President of the United States, "who perfectly inspired his pupils with admiration and love for him, because he strove to gain access into their inner soul-life, to teach them a higher conception of life, and the part they have to bear in it."

Again, if boys differ much in disposition, so do masters; and while both may be equally estimable, yet they may be incompatible, and thus incapable of getting on well together, because of continual irritations on one side or the other, really without any cause: *e.g.*, a quick, impulsive boy may unfortunately be placed with a master of a similar temperament; whereas such a boy should have been placed with a more placid, even-dispositioned master, and he might then have shown that love for his instructor which is so much to be desired for a boy during his formation of character, and which all who have had much to do with boys know to be a life-long gain to them.

Choice of a Boarding-house.—As there are schools and schools, and masters and masters, so there are houses and houses. These houses are often, and will be, with some exceptions, what parents demand them to be.

If parents be satisfied to place their boys in a house or school where dormitories allow only 300 cubic feet per boy, instead of from 700 to 800 cubic feet, that is all that will be provided for them; if parents demand cubicles, they will get them, notwithstanding their being so undesirable; if parents be satisfied that the drains of a school should be connected directly with the sewer of the *town*, they will have the satisfaction of having their sons well seasoned with sewer gas, as well as educated, if they be fortunate enough to have them escape a serious illness; if parents wish a school in the *country*, with cesspools situated on a higher level than the well, so that they can overflow into the well, and thus supply an infusion of sewage for their sons for drinking purposes, instead of the adoption of earth closets, they will find this arrangement provided for them; if parents be pleased that their sons should have water to drink unfiltered or inefficiently filtered, they will find this, too, provided for them.

What house or school improvements parents deem *necessary* they will often have to ask for, otherwise, as a rule—fortunately, with some exceptions—they will not be supplied, except under extreme circumstances which imperatively demand them; but if masters find that parents are alive to the necessity of certain arrangements in a school for ensuring its safety, and ask for them before placing a boy there, such arrangements will be forthcoming.

What a boarding-house of a public school and a dwelling-house of a private school should be sanitarily we shall consider in its proper place.

Before Entering School.

Education.—The boy should have been taught something, however little, thoroughly; whatever he may have learnt should have been inculcated with method and despatch. The plan of keeping young children at work for so many hours, quite irrespective of what they may learn, as so many children are treated, is wrong. I mean that work which ought to take half-an-hour to get through should be finished in the time, and then cease, and three hours should not be occupied by it instead; to permit this teaches a child to loiter and waste time—a habit which will cling to him through life.

Early pressure of work cannot be sufficiently deprecated, nor can long hours for young children; either may cause an acute brain illness, or entail prolonged ill-health.

Children, as early as possible, should not only be taught to exercise their *memories*, but should also be encouraged to develop their *reasoning faculties* from the very beginning, so that they may learn to think before they speak, and not ask stupid, unmeaning questions. A little wholesome chaff at home when a senseless question is put or a foolish observation made will often act as an effectual, though mild, corrective, and will save him from much of that unpleasant chaff and teasing which a boy is apt to get at his first school.

A child's *moral education* cannot be begun too early; if it be as early as it could and should be, he will act rightly almost intuitively, and will shun wrong without hesitation. If this early home training be neglected, later on it becomes a hard lesson to learn, sometimes only obtained after many deplorable falls, sometimes never learnt at all through life: the untrustworthy boy becomes the dishonourable man.

The child should be early taught *self-respect*, for his own sake as well as for that of others; he will then be ashamed to do wrong, he will feel it a self-humiliation. If he respect himself, he will soon learn to respect others, those below as well as those above him; then he will not only learn, but feel, that wholesome lesson, so important for a *boy* to know, that a school-fellow is not a *gentleman* or a *cad* according to his birth or means, but one or the other by his conduct alone. Only too well does the physician see who is the gentleman and who the reverse, for when a boy is ill his true character comes out most clearly.

Some may be inclined to think that, in a school health treatise, I am stepping out of my province in making any observations at all on education, and its mental, moral, and social aspects; but I cannot consider the boy at school apart from his surroundings—what he is and may be—because on all the points I have mentioned much of his happiness depends; and if his happiness, then his health.

Sanitary Education.—It is very important that parents should consider some few points connected with the health of their children before they leave home for school.

And, first, I would mention *proper clothing*, all clothing being used not only for adornment, but to protect the skin against cold and against warmth.

Our *skin* is about the most important gland we possess, and needs a certain amount of care and prudence to enable it to do its duty, and to prevent its being arrested in its functions by sudden changes of temperature; yet the very greatest carelessness exists, and little thought is given to its protection. To prevent its sudden exposure to the various changes of temperature to which we are all liable, our skin requires a *non-conductor* next to it—in winter, to keep in the heat and to keep out the cold; in summer, to prevent the skin being checked suddenly in its action, whether it be in the sun or in the shade, whether by night or by day; and to secure its efficient action under all conditions. What the non-conductor should be does not much signify, so long as it is a non-conductor. Yet parents will allow their sons to go to school with linen next to the skin—the very worst of all non-conductors, flannel being the best, then merino, silk, calico, and linen, in the order enumerated.

If there be a good non-conductor next the skin winter and summer, it matters little about the rest of the clothing, and the question of overcoats is then immaterial. This applies to all children, but ten times more to children from a delicate stock, or those who have been recently ill, or who have come from India and other hot climates.

Besides this, too much care cannot be bestowed to ensure *warm feet* always. Therefore, the boy should be well shod with thick boots to keep out the wet, and he should be provided with a number of pairs, so as to allow each pair to become thoroughly dry after getting wet before being again worn. The boots should be broad of sole, to prevent the foot being cramped in its growth and the natural arch destroyed, and to guard against the toes getting anchylosed from never being allowed to move. If this rule were attended to the medical officer would not always be advising about the deformed condition of the foot, and would not have so constantly presented to him those painful cases of chilblains, mostly caused by improper or imperfect boots.

There are other subjects also—*natural relief* is one of them—so commonplace that it seems almost ludicrous to speak of them, and yet when their issue is important they should not be omitted or passed over as if they were trivial. Parents so constantly neglect teaching their children that they should have their *natural relief* daily at a certain hour, and yet the neglect entails a vast amount of discomfort to the boy on coming to school, and often a great deal of ill-health, and every now and then danger. To omit laying stress on this matter would be to omit a point of much importance connected with the health of a boy at school.

This is one of the easiest and earliest lessons a child should be taught, and should be followed up with uninterrupted regularity; if observance is found to be difficult it should be enforced; in practice, medicine should seldom be resorted to. Of course, I am only speaking of what should be done in health, and am not referring to illness at all. I have never seen a child in health who really required the constant aperients which are so often given. It is simply the result of early bad management. I have over and over again shown parents that this is so by curing a child at once by a system of rewards, in the place of a system of physic. A little patient painstaking on the part of parents from the very beginning would save the trouble to all concerned. It is neglect—early neglect—and that only, which causes subsequent trouble.

ENTERING SCHOOL.

Medical Examination.—When a boy goes to school, he often has to pass through a pretty searching ordeal before his masters, in order that they may ascertain whether he knows enough to be permitted to enter the school at all, and what standard he has reached, so that it may be decided in which *form* he should be placed; by this means he is not set at work above or below his capability, but a knowledge of his working powers is fairly gained.

A similar examination is, or should be, enforced to ascertain the capacity of every "new boy" to join in all *school games*, which are or should be compulsory with every boy—for it is necessary to restrain some and to push others, so as to avoid that worst of all evils in a school, Idleness—unless his medical examiner excuse him for some significant and valid medical or surgical reason.

This *medical examination* should be as searching as a thorough examination for life-insurance, for several times I have accidentally found boys with mitral disease of the heart joining in all school games, some of which require active and prolonged exertion. This physical examination should also extend to the eyesight, a defect in which is often the cause of a boy not getting on with his work in his school, entailing very considerable suffering from intermittent, and then persistent, headache.

Therefore, just as the master regards it as an essential to the boy's succeeding with his education that he should be examined on entering school, so the medical officer should know what he is fit for and capable of physically—what exercise will increase, what retard, his development.

The medical officer should be further aided in his work for the welfare of the boy by as much information as can be given of his past life and family history; whereas, as a rule, a boy is deposited at school by his parent without one word about him that may concern him when ill, and so the medical officer has nothing to guide him as to any personal or family peculiarity. Now, this is not fair to the boy or to his medical attendant. Every information should be afforded in the proper quarter, and reticence on the part of a parent in a matter of such moment is most unjustifiable. For example, many a boy is sent to school with a decided history of consumption (perhaps a parent has died of it), and yet not a syllable is expressed to his master on the subject. Nay, more ; when asked to state in a report whether there be any consumption, a blank is left, instead of a frank confession of the possibility of inherent weakness that would be guarded against, with unspeakable benefit to the boy.

To induce parents to assist the school doctor as they ought, a *Medical Report*, signed by a parent or guardian, should accompany every boy on leaving home for school, which should give a complete personal and family history of the boy, for his own sake and that of his school. The following may serve as a guide :—

MEDICAL REPORT.

To be sent to the Master on the admission of a "New Boy," for the guidance of the Medical Officer.

1. Name..
2. Date of birth ....
3. Where born ....
4. Where resided ....
(These are sometimes very important to know: *e.g.*, whether a boy has come from a hot or malarial climate.)
5. Has he any ailment rendering "school games," or any of them, unadvisable? ....
(This should state every and any known *personal* defect: *e.g.*, Rupture, Heart Disease.)
6. Is there any peculiarity in health or constitution which should be mentioned? ....
(This should state any and every known *family* defect likely to influence the boy: *e.g.*, Consumption, Rheumatism.)
7. When was he last vaccinated? Was it successful?..............................
8. Has he had small-pox? ....
,, ,, chicken-pox? ....
,, ,, measles? ....
,, ,, rôtheln? ....
,, ,, scarlatina? ....
,, ,, mumps? ....
,, ,, whooping-cough? ....
(If "Yes," add the date.)
9. What other illnesses has he had? ....
(*e.g.*, Pleurisy.)

Signature of parent or guardian..............................
Date..............................

Vaccination.—Every boy above thirteen years old should be *vaccinated* immediately prior to or on entering his school, for his own protection and the safety of the school. It should be regarded as a disgrace for any school to ever have a case of small-pox.

Period of Entrance.—With a strong, hearty boy, it does not signify in the least when he enters his school, but to a delicate boy, or one who, though strong, has had a recent acute illness, or one lately arrived from a hot climate, it is a matter of great importance. He should always *enter his school* in the spring, so as to have the summer before him, and thus get used to the change of place and of life during the most favourable season, and so avoid the risks of bad weather at a time when he is most susceptible to its influence.

The Master's Boarding-house, and Life out of School.

In small schools all boys live together in one house, which is dwelling-house and school-house combined; but in most large schools—as the public schools—boys live with different masters in separate houses, and meet together at all other times—at chapel, at school, and in the playground; though some have a common dining-hall, where the whole school meet at dinner—a plan not to be recommended.

These boarding-houses accordingly are a distinct element in a large school, and they vary much in all schools and in the same school. If a parent will bear in mind what I have already said, he will carefully select the boarding-house and boarding-house master that may suit his son best.

Studies.—In private schools the boys, generally, do not have a study, but all live and work together in a common school-room. This is an excellent plan, and, provided the school-room be sufficiently capacious, a very healthy one. For small boys it is always the best arrangement.

In public schools the boarding-houses are supplied, as a rule, with studies, but these are of two kinds.

First, the study pure and simple, which a boy has to himself, or shares with a brother or a school-fellow. These are excellent, cosy little rooms, where a boy can work well, either alone or with his fellow; and if a master be careful to arrange his boys in their studies as he should, with especial reference to their characters, no harm results. They are a great comfort to a boy, for he feels, amidst all the publicity of school life, that he has some small place in the school-world that he can call his own, and where he can be quiet and alone sometimes; and they are not too private.

They often might be larger, though even the proverbial 6 ft. × 4 ft. study I do not condemn, for a boy is rarely long enough in his study to get harm through insufficiency of air; and if he be there for any length of time, the door is usually open all the year round, while in summer the window is often open as well, and in winter there is a large fire burning. In some cases, however, no fire-places are provided for studies, but they are warmed by hot-water pipes, or by hot-air flues, or simply by a passage fire. They all might be, and should be, better ventilated, and with some reference to sanitary science. If all fires in studies were done away with, and they were warmed with hot-air flues instead, endless expense would be saved, and a continuous supply of warm fresh air could be supplied to each study.

That these studies do occasion harm every now and then under the present system is beyond a doubt; thus, a boy often makes up such a huge fire that he cannot sit in his study when he has made it, on account of the heat, so he either opens the door and window and sits in a direct draught, or he goes out of doors to cool himself. I have known cases in which a severe illness has followed an acute chill so caught.

In some schools, while all boys have these studies, the smaller boys are not allowed to use them in the evening, but are assembled together in a common room, to prepare their work for the morning, in the presence of a master. This plan is excellent for the boys—though a tax, perhaps, on the masters—for more and better work is got out of them, and there is less scope for that rowdyism and bullying in the studies and passages during the long winter evenings that there used to be in days gone by.

It is a very bad plan to combine the study and sleeping-room in one. First, because the boy is in the same air day and night, perhaps studying with a light burning all the evening, and then sleeping in the exhausted air; and, in the second place, they have all the bad features of cubicles, on which subject I shall have more to say presently.

Sleep.—Sleep for growing boys is an important matter—for growing boys, doing a full amount of brain-work, a very important matter indeed. If there be a tendency at all in schools, it is towards too little rather than too much sleep; in fact, in public schools, I think, boys scarcely get enough, especially the younger ones, and were it not for holidays coming every twelve or thirteen weeks, I do not believe they could continue in health, and yet do well their full share of work. It must be remembered that they not only have to repair waste—the ordinary wear and tear—as adults have, but they have also to provide for growth; thus all their organs have extra work to do, and so require extra rest to recover strength. Moreover, boys are more active in mind and body, and thus there is again an increased wear and tear, which also needs a still further increased period of rest for repair.

The amount of actual sleep required for boys under ten years of age is eleven hours; and the best time for it is, except on the very hottest nights in summer, from 8.30 p.m. to 7.30 a.m. For boys under thirteen years of age, ten hours and a half should be set apart, from 9 p.m. to 7.30 a.m.; breakfast should follow at 8 a.m., and school at 9 a.m. For boys above thirteen, the eight and a half or nine hours usually permitted, but never obtained, are not too much, if enough, considering their active period of growth, and the amount of mental and bodily exercise they undergo. In bed at 10 p.m., which means sleep not much before 11 p.m., and called at 6.30 a.m., for chapel at 7 or 7.30 a.m., is, I believe, the rule in most public schools. With only this amount of sleep some boys seem weary, and look as if they did not get sufficient rest.

Dormitories should be places to sleep in only, and should be always closed to all boys by day; it is better for the rooms themselves (for cleanliness and ventilation), and far better for the boys. They should be large, and open to the view of every occupant of the dormitory; ten or a dozen beds in each is a good, if not the best, size. Their temperature should average 55° to 60° Fahr. Where it is possible, they should face south, and the windows should go well to the top of the room, so that when open they clear the upper stratum of air.

At the head, and responsible to the master, of these rooms should be the best senior boys, or præpostors, that the house possesses. Each of these boys should be responsible for the conduct of the dormitory under his supervision. He should be the trusted friend of the master and of every upright and pure boy, but the enemy to every boy capable of any impure hint, word, or act. By his personal influence alone he may, as I have known, keep the whole tone of a house, and especially of a dormitory, as pure and healthy as could be wished by even the most fastidious.

Cubicles in large Dormitories.—These cubicles consist of a large room, partitioned off either by boards or curtains into a series of little rooms, the partitions usually not being carried to the ceiling.

They are, from my point of view, a direct invitation to impurity; and I think no school has any right to put this unnecessary temptation in any boy's way, however good he may be.

I know a master who has those cubicles in one of the dormitories at his school. I have told him how I should like to set fire to them. His answer is, "Oh, but every parent, on viewing my dormitories, always remarks, 'What delightful little rooms! I do hope my boy will have one of those little beds in those cubicles, and not one of those in the large dormitory; they do look so nice, clean, cosy, and comfortable—so home-like.'"

I have no doubt whatever that this is the observation of most parents who see those comfortable-looking cubicles. They may be pleasant to look at, but their very privacy may become a source of danger, and there is very much to be said in favour of an open dormitory, with a præpostor, chosen for his character rather than his ability, at the head of it. On parents, therefore, really rests the onus, if they ask for these cubicles, or place their sons where they exist; and on their shoulders, therefore—not the master's, or the boy's school-fellows—rests the blame if their sons become corrupt.

Cubicles in themselves may be everything that can be wished for where a healthy tone and conduct exists; but where there is the least unhealthiness in tone—as there always is amongst a number—they foster it, and are an invitation to it, by the privacy they afford.

Every parent should quietly and kindly warn his boy, before he first parts with him at the very beginning of his school life, that he will, wherever he goes, meet with some bad companions, who will try to teach him bad thoughts, bad words, and bad habits; and the parent might well tell his son, as Tom Brown's father did, "never to listen to, or say, anything you wouldn't have your mother or sister hear, and you'll never feel ashamed to come home, or we to see you." By this means most of the evil referred to would be done away with, for the boy would be on his guard in the first instance.

But a parent, as a rule, will not like to do it, and will trust to a boy's honour, or to the master telling him, or the doctor. *It is the parent's duty, and his alone.*

The great question is, What is the remedy for this wide-spread evil?

1. A timely word of warning from a parent.
2. A more reasonable prefectorial system, where *character* should rank *above*, but not *without*, *ability*.

3. Large open dormitories only.

Size of Place for Sleeping.—I think Dr. Parkes has conclusively shown that every adult requires 800 cubic feet of space for breathing in, and that with efficient ventilation besides, so as to render the air sufficiently pure to carry on respiration without draught. He showed that air containing more carbonic acid than ·6 per 1,000 volumes is poisonous. To prevent this occurring, 3,000 cubic feet of fresh air are required to be replenished every hour. If this air be changed more frequently than from three to four times an hour by ventilation, too much draught is occasioned, which no one can comfortably bear in our climate. Therefore, 800 cubic feet of space should be supplied for each boy.

Masters will naturally say, "But I have provided efficient ventilation." Yes; but if you have so small a cubic space per head that to get proper ventilation the air has to enter with a rush, no boy will put up with it. Consequently, one sees all the ventilators stopped by the boys with various articles of clothing, from a sock to a dressing-gown, according to the size of the ventilator.

Of course, in warm weather air may enter very rapidly without perceptible draught, and so less cubic space may suffice; or if the in-coming air be artificially warmed, it can be admitted much more freely without draught being felt, and then, again, a smaller cubic space will yet be sufficient; but as a rule, in our climate, 800 cubic feet of space is what ought to be provided in dormitories.

Ventilation for dormitories should be obtained from the open chimney, or by means of ventilators over doors into passages, which in their turn should be well ventilated; or by "conical brick" ventilators fitted into an outer wall; or, again, by Tobin's system; or a two-inch piece of wood under the lower edge of the window-frame to prevent it from quite closing, and allowing the admission of fresh air between the two sashes in the middle of the window, which plan I cannot speak too highly of, for it is efficient in action, cheap in cost, and within the reach of every one.

Warming.—Warmth for dormitories can be supplied by the open fire, or, still better, by hot-water pipes.

Warming and ventilation combined can be provided for dormitories by hot-air flues, or by one of the patent grates; and if *warmth* should ever be supplied for the dormitories of schools—a point which I should not myself generally advocate, as making boys unnecessarily sensitive—it should be this warmth combined with ventilation.

The plan of warming dormitories by freely lighting the gas should never be followed; it is bad in the extreme; better have no warming than such warming, which burns up all the fresh air: but it may be well and legitimately used to assist in warming and airing the dormitories for the last few days of the vacation, before the boys return to school, *provided* the windows be left open about an inch at the top.

It is a point of great importance in the dormitories of schools that sufficient *superficial area* should be provided for each boy, and that beds should not be placed side by side, so close together that you can only just get between them; and this for more reasons than one. One disadvantage of this close packing is, that if an infectious illness attack a boy in one bed, the occupant of the adjoining bed is almost sure to be infected.

Therefore, superficial area is of great consequence; and, taking a boy's bed at school as 3 ft. × 6 ft., the superficial area should be quite twice that, 6 ft. × 12 ft., and the room itself 11 ft. or 12 ft. high—the latter the better, as it supplies enough air—864 cubic feet—to allow for that which is displaced by the furniture of the room and the body of the boy.

It is said by some that boys do not want this amount of air, because they are not fully grown. I should say, a growing boy, in whom all changes are much more active than in an adult, needs even more air than an adult, for his respiration is more active, and I believe his expired air is more highly charged with carbonic acid gas than that of an adult, on account of the great activity of this tissue change.

And not only this, but I am sure that the young throughout the animal creation are much more sensitive to impure air than adults, and in them, therefore, re-breathed air is much more poisonous. Moreover, in a large school we have boys of every type of constitution and every degree of stamina, representing every constitution under the sun—among them, many boys from a tubercular stock. Who will gainsay the vast difference it makes to that unfortunate boy, during his years of development, whether he have plenty of fresh and pure air, or whether he have simply to breathe the same air over again? It may make this difference to him—whether he become a tubercular or non-tubercular individual: whether he die early or live to maturity.

Meals.—I am a very strong advocate for early "first lesson" at 7 or 7.30 a.m., before breakfast, for public school boys, except for the first few mornings on the re-assembling of the school in January, when the change from home life would be too abrupt; but for private schools, where the boys are younger, in order to allow more time for sleep, I should insist on breakfast first, at 8 a.m., to be followed by school at 9 a.m.

While, however, I am an advocate for early first lesson, as it teaches boys to get up early, allows more time for work, and an extra hour for play, yet I am a great opponent to early first lesson at 7 a.m. on an empty stomach, not only for growing boys, but for masters also, especially during the worst time of the year; and would therefore very strongly urge the importance not only of every master providing, but also of every matron seeing that every boy takes hot milk or hot coffee, with a piece of bread, before he goes into school at all. For the very strong boy, perhaps, it does not matter so much, but for the delicate boy, and even for the average boy, it is a trial to his strength, and an unnecessary and wrong exposure to commence work without it.

I would advise hot coffee, with plenty of milk, before first lesson, as being a gentle stimulant to the nervous system, invigorating without depressing.

After first lesson, breakfast—which is the most important and health-giving meal of the day—can be taken at leisure, and with appetite.

Growing boys would be greatly benefited if masters would use their influence to try to induce them to eat "whole-meal" bread: but I mean "whole-meal," and not simply bran bread.

As much bread as a boy can eat should always be provided. The crust is twenty-five per cent. more nourishing than the crumb; and butter should be given with it when eaten alone, to make it a staple food, as bread contains little fat of itself. I would also urge on all masters who have pupils to feed, the perpetual necessity of seeing that the bread be wholesome, for while one batch may be everything that could be desired, the next may be either sour or musty, and not only uneatable —except under the stern necessity of hunger—but positively harmful to the recipient.

No growing boy should be stinted in sugar or sugar-forming food such as starch; it is an essential to him, his chief heat-forming food, and preferable to and more digestible than fat, though he cannot live in health without some fat in his diet.

Milk should always be bountifully supplied for all adolescents, as part of, and an essential to, their staple diet.

As milk has been shown to be such a fertile cause and spreader of disease amongst all communities, the very greatest care should be exercised in the selection of the supply for all great schools; and while one scarcely likes to advise anything that may seem to interfere with the freedom of the master in his choice of his purveyors, yet I cannot but think that a greater safety would be found in obtaining the supply of milk from the school's private dairy; or from one large farmer, whose farm-yard, cattle, and dairy should be under the supervision of the medical adviser to the school, for by this means greater care would be taken by the farmer, not only because of the medical supervision, which would be a marked check, but also because the propagation of disease from his dairy would mean, at all events, temporary financial ruin, thus making him scrupulously careful to reduce the risk to a minimum. Of course, I am quite aware of the argument on the opposite side, that where you obtain your milk supply from half-a-dozen sources, in case of a milk poisoning only a sixth of the school would be affected, instead of the whole; but, notwithstanding that, I maintain that the risk is more than six times as great where there are six possible centres of poison.

There are some masters, physicians, and moralists who hold that a boy should be allowed meat only once a day; for young boys, to this I agree: for the average public school-boy, I do not think it is sufficient. He needs meat twice a day during his actively-growing years, which is during the time he lives at a public school. It will be admitted by all that to produce the highest state of health in the adult, meat once a day is at all events essential to cover his wear and tear. If that be true, then I maintain that a boy needs meat *once* a day also to provide for *his* wear and tear, which is far more active even than in the adult; and, I would add, he requires meat a *second* time to supply his means for growth besides. The meat should be given at breakfast and at middle-day dinner, and on no account in the after part of the day.

By meat, I do not mean only butcher's meat, but I include all that class of nitrogenous food—meat food, as distinguished from farinaceous food—which comprises also fish, bacon, sausages, eggs, &c., &c., with which a boy's breakfast is sometimes varied.

The *quantity* of meat or nitrogenous food supplied in the twenty-four hours at this breakfast and dinner should be one pound of uncooked meat, including fat, which means 20 per cent. of weight of bone, 20 per cent. of weight which is lost in cooking, therefore giving 60 per cent. of fat and lean cooked meat, or 9·6 oz.

I have given the full amount of meat food that is wholesome for the strongest and biggest boys, or those who are growing rapidly. I have done this purposely, though I am aware that younger and less robust boys could not get through the amount I have specified; for them, three-quarters of a pound of uncooked meat is the usual amount required.

If ever we islanders get over our national disgrace, and are able to obtain our fish at a fair price—if we had not a coast-line at all, it could not be much dearer—I trust our schools will make it much more an article of diet for adolescents than is at present feasible, for it is an excellent food, containing about 95 per cent. of fibrine and 5 per cent. of fat, which is more fibrine and less fat than meat itself, except salmon—which contains 78 per cent. of fibrine to 22 per cent. of fat—and eels, 44 per cent. of fibrine and 56 of fat.

Vegetables are a necessity to ensure health, especially green vegetables, but, as a rule, boys will not eat them in the autumn and winter, when cabbage is the prevailing green vegetable; consequently, every autumn and winter plenty of eczema is seen. To obviate this, in the winter plenty of soup, with vegetables, should be given once or twice a week; beet-root, too, can generally be obtained, is liked, and is wholesome.

I often hear and read of complaints about the food at schools, especially dinner, being bad. At our public schools, and at our best private schools, I believe this is wholly untrue, for I am sure the masters buy—and see that it is supplied—the same for the boys as for themselves. At the average school I hope and believe the feeding is vastly better than it was even a few years ago.

There is, however, sometimes a matter for just complaint, both by parents and boys, in the *cooking* of the food, meat, and vegetables, but especially the latter, and this is why they are so often not eaten by the boys.

The food may be the best which can be bought, but if it be badly cooked, especially if the meat be so under-done as to be a blue-red, or if the green vegetables be imperfectly washed, and contain grit, insects, or slugs, or, being insufficiently strained, be swimming in the water in which they have been boiled, I, for one, could not eat them, however hungry I might be. It is, no doubt, a difficult thing to cook for a large number, but this can be and is overcome by a careful master seeing to the matter himself, and dining with his boys, thus making sure that the food is well and nicely cooked and properly served; and he should also encourage all just and reasonable complaints to be made to him by the boys, as tending to keep the servants up to the mark, instead of to parents at home.

It is important for the well-being of boys not only to have good food, and to have it nicely cooked, but also to be allowed time to eat, instead of *bolting* it. It is often this that gives such indigestion to a boy that he gradually gets a natural dislike to and loathing for what he should eat, because it generally disagrees with him.

Some boys—generally those who have most money—complain of and do not eat their dinner; the reason being, they go to the pastry-cook's not long before the dinner-hour, and there regale themselves, so that when they should eat their staple meal they cannot, and complain about the food provided for them by their master. Is there any reasonable being—even a boy—in the world who thinks it possible that after enjoying all the tit-bits at a pastry-cook's he could come away and sit down to a meal of meat and potatoes without finding fault? This ought to be stopped, as it interferes with the boy's health. Masters should try to induce the boys to keep their pocket-money until after dinner, and then spend it if they will. Failing to induce the boys to do this, I think masters should go a step further, and request the pastry-cooks not to serve boys before dinner-time at all. I think the shops might well be out-of-bounds—say between 10 a.m. and 2 p.m.—so that the boys should be enabled to eat their staple diet of meat and vegetables before the delicacies—by no means to be despised or forbidden—furnished by the pastry-cook are allowed.

Hampers from home are a constant source of illness, from the things they contain. It is very nice, no doubt, for a boy to receive a present from home while at school; but parents should send nothing that can make the boy ill, either from the quantity or quality of its contents.

The question of beer in schools I regard as a very important one. I believe it to be unnecessary to a boy, and would like to see it, as is gradually coming to pass, less and less used by the boys themselves as an ordinary article of diet.

The animal propensities of boys are quite active enough without the *stimulant* effect of alcohol, and they are always ready enough for sleep without its *sedative* action. There is, roughly, only one other property of alcohol: that is, its *heat-producing* power, for supplying animal heat; but for adolescents the best heat-producer is sugar, which far exceeds fat or alcohol.

Boys are better without it, as they do not need it; but to help them to give it up, it is essential that parents and physicians should co-operate with masters.

Beer is usually provided for boys at school, and, if drunk at all by them, should be taken at dinner only. But it is used less than it was, and milk more, which is as it should be—for milk is a very important item in a growing boy's diet.

As a remedy in sickness, I use alcohol whenever I deem it requisite; and this, in my opinion, is the only way in which it should be used in schools.

With some boys, and parents too, drinking is lightly regarded. Therefore boys and parents should be made clearly to understand that *drinking, and smoking also* (usually begun at home), *for growing boys are very bad, owing to their effect upon the nervous system*, quite apart from the moral reasons for abstaining, and the prohibitory rules of the school. The master's position in enforcing such salutary rules should be strengthened by both the parent and the physician.

After middle-day dinner, all the food taken should be light and easily digestible, so that the boy can do the maximum of work, sleep most easily at night, and get up at 6.30 a.m. with pleasure.

Sanitary Arrangements of the Boarding-house or School.—Unaired beds are a possible source of illness in all schools: the unoccupied beds of the boys during the vacation get damp, however well the rooms may be aired; and before the re-assembling of the school, at the commencement of each term, every mattress needs very careful airing, which should be systematically carried out, under the superintendence of the responsible master.

In towns, schools should always be supplied with water from the local water company, and this supply should be constant, and on no account intermittent. No well in a town should ever be allowed to be used, for, with the ramification of drains which always exists, it is utterly impossible to keep out the surface water, and prevent the contamination of the well from the usual leaking of drains.

In the country, in all great schools where it is feasible, a private Artesian well to supply the whole school should be provided. Where this is impracticable, and yet a well must be used, the sides and top should be carefully puddled with clay, to keep out as much of the surface water as possible. It should always be on a higher level than, and at a distance from, the cesspool, and clear of all surrounding drains. The reverse of this is what usually obtains, so that when floods or excessive rain occur, or the cesspool is omitted to be emptied, and therefore overflows, its contents find their way naturally into the well, and thus poison the whole school. I have known diphtheria and typhoid fever to result from this cause. It therefore behoves parents to see to such matters before placing a son at school, if they wish to be spared illness—perhaps worse.

Cisterns should always be provided for all schools, at the highest convenient part of the house, so as to ensure water being readily available all over the house; for if it have to be carried up-stairs by servants, the supply will be stinted, which should not be. These cisterns should be well protected from the entrance of extraneous matter, and should be thoroughly cleansed out every vacation, before the re-assembling of the school. The overflow-pipe should either be carried out of the wall on to a subjacent roof, or simply pierce the wall and be cut off, so that any overflow may be visible at once; it should never communicate directly with a drain.

Every school and boarding-house should have its own filter, and that an efficient one, and not simply a sponge-filter. The best filters are the "spongy iron," the "silicated carbon," "Dr. Bond's aerating," and the ordinary "carbon" filter.

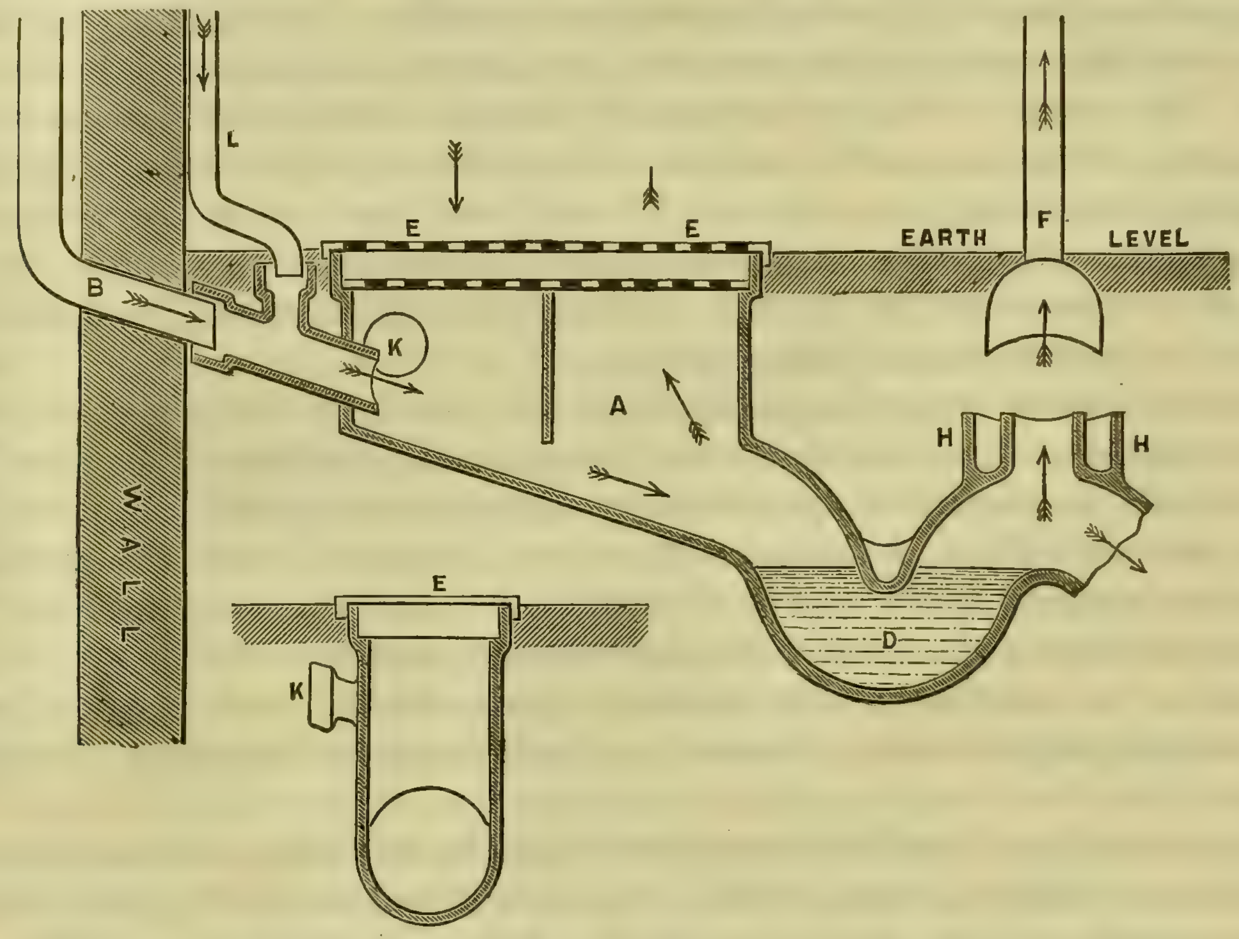
In schools situated in the country, the cesspool should, if *practicable*, be far away from the house, on a lower level than, and at a distance from, the well, freely ventilated, and cut off from the soil-pipe absolutely, just *as if it were a town sewer*, so that no generated gas can by any possibility get into the house.

If this be *impracticable*, there should be no cesspool at all, but *earth closets* should alone be used—each one being separated from the other by a partition, and well ventilated above and below.

In schools situated in *towns* where sewers are in existence, they should be employed, but all house-sewers should be cut off absolutely from the street-sewer. There are several excellent traps which effect this, and one or other of them should always be used; most of them answer their purpose well.

The one I have at my own residence is an absolute preventive against sewer gas —from a cesspool or a sewer—getting into a house, and works admirably, without any defect, because of its simplicity. It was invented by an intimate friend of mine, a schoolmaster, who, having had the misfortune to lose a child from diphtheria, and having had several pupils ill with it as well, set to work to try and keep foul gas out of his premises; and he brought forth this ingenious trap, now called the "Edinburgh Air-chambered Sewer Trap." Every pipe for drainage purposes in and about the house should open into this air-chamber, and should never be attached directly to the sewer-pipes.

In schools all the water-closets that are in use by day should be out of doors, occupying a detached building; but they may be so contrived as to be got at in the evening by opening another door, locked by day, without going out into the open air after dark. Each closet should be separate and distinct, well ventilated above at the highest point, and below level with the floor, so as to prevent all accumulation of foul air, however much in use; the floor should be of brick, stone, or tile, which can be flushed every day, and on no account of wood or earth; the water supply should be copious. Moreover, since boys are careless and the closet is in constant use, it would be better if it were always self-acting, or so contrived that a single pull of a handle would empty the requisite quantity of water—about three gallons—each time the closet was used.



K, junction for one or more closets, &c.; E & E, iron grids for ventilation. A socket, H, is provided for ventilating-pipe, F, to be carried above windows; next is a syphon or water-trap, D; then an air-chamber, A, to carry off any residue of sewer gases (if any) escaping through trap. B, soil-pipe; L, rain water, sink, or other house waste water-pipes.

A good water-closet should be also within easy reach of the dormitories, for use in the night if required; and if the sewer or cesspool have been cut off from the house (as it should be in every case) by an open air-chamber, and if the closet itself be also well ventilated, no harm can possibly ensue. To connect any house-sewer or house-pipe directly with the main-sewer of a town, or even a cesspool, as is often, nay, generally, done, is simply to lay on sewer gas to the house just as one lays on coal gas for lighting purposes. But besides this severance of the house-sewer from the town-sewer, the soil-pipe coming from the water-closet should be ventilated from its highest point by a pipe three to four inches in diameter, which should be carried to the highest point of the roof, distant from a window and from a chimney. The soil-pipe should always be outside the wall of the building, and should never pass under the house in its passage to the sewer.

Notwithstanding all these precautions, it is the duty of masters to constantly inspect water-closets at all odd times, otherwise the servants will rarely be found to keep them clean. All attention to drains should take place, if possible, during the vacation; but a grave fault detected during term should be rectified at once, and not be left imperfect until the vacation.

Urinals, out of doors, should always be provided for boys' schools; and the best are those which have the white china or glazed earthenware pans, for they are cleaner, and in these there is no sediment deposited, or the sediment is so slight and little adherent that it is removed without any difficulty. The slate slab urinals may be used where there is a constant free flushing by water; but have them as you may, their somewhat rough surface will allow a deposit of sediment, which in warm weather is neither wholesome nor agreeable to smell; where they are employed, this sediment should never be allowed to accumulate, and whenever it makes its appearance, should be immediately scraped off, or dissolved off with a mineral acid.

Stone and cement slabs should not be permitted, owing to their exceedingly rough surface causing a constant deposit of sediment, which it is almost impossible to remove from them. The pipe carrying off the fluid from all urinals should open into an air-chamber, and not be directly attached to the drain leading to the sewer.

Lavatories should always be provided in schools for washing by day, in order that the dormitories may not be visited at all except for sleep at night. The basins should have pipes from them to carry off the dirty water, and the pipes should not directly communicate with the soil-pipe or sewer, but should discharge themselves either into the air-chamber of a suitable trap or on to an open iron grating outside the house, placed over the ordinary syphon gully-trap, or over a ventilating trap, the pipe from which should still not be attached directly to the sewer, but should open into the air-chamber of such a trap as the "Edinburgh." By this means no sewer gas could enter the house through this channel.

A housemaid's sink, or slop-receiver, should, for the convenience of the servants, be provided up-stairs for all schools where many slops have to be emptied. It is best made of white china or glazed earthenware, being thus cleaner and sweeter than any other, and not liable to the accumulation of deposits : in this respect it is far superior to lead or stone sinks. The hole in it should be at least three inches in diameter, and protected by a wire cradle or sieve, with meshes not too close together, the pipe from which should be syphoned immediately beneath it, so as to keep air from rushing up; below, the pipe should terminate as described above for Lavatories.

It is just as important that the kitchen should be protected from sewer gas, for the gas may not only contaminate the food, but spread all over the house. Therefore, the pipe from the kitchen sink should open on to an iron grating outside the house, which should cover over a good grease trap, to collect all the grease from the kitchen, and so not obstruct the drain, the pipe from which should be arranged as described above.

Cellar drains, being one of the most fertile sources of sewer gas entering a house, should also open into a chamber like that of the "Edinburgh" trap, and on no account be attached directly to the sewer, as is so constantly done.

Baths, with hot and cold water laid on, should be provided in every school, where a boy can wash all over with soap and hot water at least once a week, besides his dip in the swimming-bath every day and his cold bath after games.

The waste and overflow-pipe from the bath should not communicate directly with the drains, but should be syphoned underneath and open below on an outside iron grating, just as in the case of lavatories. The number of lives lost and illnesses caused in this country through the bath waste going directly into the drain is incalculable.

In country schools the dust-bin and refuse heap should be at a long distance from the house, at the remotest part of the premises, and where the boys do not go; in towns none should be present, but all refuse should be moved from the house at least twice a week by the Local Board of Health, this decomposing refuse matter being a frequent source of infectious illness.

Wherever it can be arranged, all dirty linen should be washed on the premises, under the inspection and at the responsibility of the school authorities; the risk of having infection brought into the house from a common laundry is thereby obviated. Where this cannot be carried out, it would be best to have the whole washing of a school done in one large laundry in the country, which should wash for no one else. When every boarding-house arranges for its own washing, the greatest care and supervision are necessary, as the laundry is a well-known loophole for the entrance of infectious illness into a school.

An annual sanitary inspection of all great schools should be carried out by a competent inspector, not interested in, or in any way connected with, the school. It is essential that he should be a man of practical experience in schools, and well versed in sanitary science.

I have endeavoured in this section to show how important a duty it is for parents to see that a school-house is thus perfectly severed from all direct communication with drains before they place their son at the school. It is only thus, as a rule, that necessary sanitary arrangements in schools will be carried out.

SCHOOL.

Chapel.—Some private schools have a chapel of their own, others use the parish church; most public schools have their own private chapel, which is used either once a week or every day of the week.

For some time during the year these chapels need artificial *warming*. Now, there are two ways of warming a chapel: the *right* way is to light the fire on

Monday morning, and let it out—if at all—on Saturday night; the *wrong* way is to light it on Saturday night, and let it out on Sunday night.

It would be bad enough to use a chapel once a week without any warming at all, but in this case the walls, floor, and seats would all be only cold; but it is infinitely worse, I think, when the fire is lighted on Saturday night, for the moisture from the warmed air simply condenses on the cold walls, floor, and seats, and makes them all reeking wet, producing far more colds and discomfort than if the fire were left alone altogether, besides causing mildew, which is so deleterious to health. Therefore, in all cases, whether the chapel be used only once a week or every day of the week, the warming should be continuous; for to send boys to chapel once a week with reeking walls, and to chapel every morning at 7 a.m. when the chapel is not thoroughly warm, is both a disagreeable and a dangerous practice. But while the warming should be efficiently carried out, it should not be excessively done: the chapel should not be made into a hothouse. As it is, colds are caught and serious chills occasioned, without this excessive heat, owing to the imperfect *ventilation* of chapels not allowing the air to be sufficiently pure, on account of the large numbers present and the exhaustion of the oxygen by the gas; the system consequently becomes depressed, and much more susceptible to a chill on leaving the chapel.

The ventilation of chapels is a matter which should engage more attention than it does. It should not be difficult with the constant circulation of the warm air with which they are usually warmed. Yet a very large proportion of colds are distinctly traced to chapels and churches, not so much, I think, from the imperfect warming as from the depression caused by the respiration of re-breathed air, and the poisoning occasioned by the respiration of the burnt fumes of gas.

Class-rooms.—All school-rooms should be well ventilated, and warmed to a temperature of 55° to 60° Fahr. The light should come from windows high up, and there should be plenty of it.

Every boy should be allowed about 500 cubic feet of air to breathe in, besides thorough ventilation: for it is a prime fact that the growing boy, like the growing plant, requires pure air and plenty of light.

It is a good rule that all class-rooms should be vacated every hour or every hour and a half—even if only for five minutes—for a thorough flushing by fresh air, besides the constant current during their occupation.

As a rule, all public school class-rooms are large enough, and well ventilated; but in many the desks are not arranged as they should be, with the light on the left of the boy, by which means the best light is obtained without shadow; nor in many of the older schools is the light sufficient, so that boys are made to stoop and damage their sight through this serious defect, which could so often and so easily be remedied.

Therefore, in building new class-rooms all these points should be attended to, and they should be warmed and ventilated at the same time by hot-air flues, or by Galton's grate, or on the principle of the Calorigen.

All class-rooms on the ground floor ought to be properly under-ventilated as well, so as to ensure a dry basement, and prevent the continual rising of damp air between the boards, charged not only with moisture, but also with the noxious effluvia from dry rot and other fungoid growths.

The electric light will soon do away with the evil of gas, I trust, for lighting class-rooms, for every burner consumes as much air as an adult, and poisons it far more with its fumes.

The question of seats in class-rooms is a matter of very great moment, both as to their arrangement with regard to the light, and their height for the comfort and the health of the pupil. It is important for the boy, but trebly important for the girl.

This subject has been treated with such a masterly hand by that able man, Dr. Liebreich, in his lectures on "School Life, in its Influence on Sight and Figure,"* that I feel that anything I can say would only spoil what he has already said so well. I shall therefore only give a short analysis of these lectures, to show how important is the subject. I, at the same time, strongly recommend every master, parent, and boy to read them in their entirety.

Dr. Liebreich has shown that short-sightedness is developed almost exclusively during school life, often where a tendency to it is pre-existing, but sometimes where there is no such predisposition, so that it is continually on the increase; and this short-sightedness is not only itself a direct inconvenience to the individual, but the efforts of the child during its growing years to assume a posture favourable to seeing, cause stooping and curvature of the spine, so that deformity and consequent ill-health are the frequent results. Besides this, by insufficient and wrong position of light, a diminution of acuteness and of endurance of vision is produced, so that work has to be given up or diminished.

The right form of school-room is oblong, with the windows high up on one of the long sides of it; the forms, which should have properly-regulated backs, and desks close to them, should be arranged parallel with the short sides, having the windows on the left as the boys sit, with the master at the end facing them. No boy should read with the book nearer than from 10 to 12 inches; and the desk should be raised as an inclined plane, 20° for writing, 40° for reading.

Gas-lights should be protected by a glass cylinder, to produce a steady light, but should not be covered by ground glass shades, which obstruct so much light; and reflectors should be used.

The edge of the desk or table should be perpendicular to that of the seat, and the top of the back of the seat should be one inch lower than the edge of the table for boys, and one inch higher than the edge of the table for girls.

The *amount of work* is a matter of paramount importance to the growing boy, if his brain is to be developed and not stunted from early over-work; for it is one of the strongest physical laws of nature, which holds throughout the whole animal creation, that immature organs are incapacitated and deteriorated by too much work, whereas they are developed, and made strong and active for adult life, by sufficient healthy and progressive exercise. But this exercise should be progressive, and not stationary, for mental and physical exercise fit for a child is not sufficient for a boy, and exercise suitable for a boy is not enough for a man; and the converse is also true: that the exercise which is fit for a man is too much for a boy, and that which is suitable for a boy is too much for a child.

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This appropriate amount of work, of course, varies with individuals, according to their stamina and their mental ability. What is hard work for one is scarcely work at all to another. Still, the question which all teachers naturally ask, and which they expect to be answered in a practical way for their every-day guidance in the management of their pupils, is, "What is this amount of work which should be done?" The only answer is one of *scale*, for what is suitable for the age of nineteen is most unsuitable and detrimental to the age of seven. The best scale that I can give is, I think, the following, as the ordinary amount of work for the average boy, including Sundays, but exclusive of the perfect mental rest during the periodical holidays, which, as a rule, comprise about four months in the year :—

From	7— 8	years old,	12	hours	per	week.
,,	8—10	,,	18	,,		,,
,,	10—13	,,	24	,,		,,
,,	13—15	,,	30	,,		,,
,,	15—17	,,	36	,,		,,
,,	17—19	,,	42	,,		,,

Some will be inclined to say that this is far too little, but it must not be forgotten, as is sometimes the case, that boys have to provide for their growth and development while they are at school, and so too much must not be required of them; and when a boy is growing very rapidly indeed—exceeding the $2\frac{1}{2}$ inches annually—his work should be still further slackened, for he simply has not brain power to do it. All the nourishment he takes goes to make quantity, and not quality.

This leads me to say a word on *over-work*, which term is relative, and not absolute. It is seldom seen at schools, but, unfortunately, it is occasionally. The brightest and most promising boy is most likely to work at too high a pressure; and if he be not checked in time, his life may be the forfeit. Generally, however, it is the boy who is growing too rapidly who suffers from over-work. The boy who takes no exercise may be said to suffer from relative, rather than from absolute, over-work: with proper exercise he would make healthy blood, and with proper blood he would have a healthy brain, able and ready to do all required of it.

Headaches, restlessness, irritability, inability to fix attention, are the finger-posts which usually point to the commencement of the symptoms of over-work; their warning should be heeded in time, and the work should be stopped.

But one so often hears of over-work where no over-work exists, that great caution and much judgment should be exercised by all concerned that an error be not committed, and a boy spoilt and made lazy where there is no necessity—really nothing in the shape of over-work. Thus, headaches are sometimes caused by the boy working or sleeping in impure or re-breathed air; often through a failure in sight, which could be, and should be, rectified at once by appropriate spectacles; and most often of all these headaches are toxæmic, from imperfect action of some of the secretions. On several occasions I have seen boys with all the symptoms of over-work, and out of whom no further work could be obtained, cured of all the head symptoms, as soon as the cause was discovered, by an aperient and twenty-four hours of milk diet only.

But the *arrangement of work* is only a little less important than the quantity of work, if the greatest amount of good work is to be obtained, with benefit, instead of detriment, to the boy. An hour or an hour-and-a-half at a time is ample; more is never endured easily: a few moments' respite even will allow another hour to be well gone through. Even an adult is over-strained who sits for three hours at a time at work without rest; how much more unreasonable is it to expect a young active boy or girl to do it consecutively, as is so often required. An hour in and an hour out of school is an excellent plan, especially if every other day be one of work all day, followed by half a day of freedom from work; it is far better for a boy than having less work each day, and a little more leisure each day too. Nothing is so salutary as the half day of freedom every other day, and good hard work on the intervening day, for all young people require and revel in a long time of freedom.

In private schools it is customary for all boys to prepare their work together, but in public schools the best plan is for the senior boys to prepare their work in their own studies; the younger boys should not have this liberty, but should assemble together in the evening in a common room, and there do their work, with a master superintending, but not helping. Where this plan has been tried it works admirably, and should, I think, be made general, if it be not so already. It gets more work out of a boy, gives him plenty of fresh air during evening working hours in a large room instead of in a small study, and allows the elders quiet for their work. It is a very great gain to the boys, at the expense of the freedom of the masters. But it has another very good point about it: it provides a custodian for the younger boys during the evenings, and prevents much of that rowdyism and *bullying* which has always been most rife during the long winter evenings, and which, I suppose, will always exist to some extent as long as there are boys in the world; but it is a great thing if a master can by any means reduce it, whether his mode be by occupying every spare moment of the boy's time, or by his own personal influence and kindness of heart, or by showing his contempt for the bully. The forward insolent boy is not hurt by bullying, but sometimes benefited, though many a gentle and retiring boy is, while he remains at school, made seriously ill in consequence; his growth is arrested, his health is undermined, and his spirit is crushed for the rest of his days. It is this boy who needs the protection of his master and of his elder school-fellows; and this leads me to say a word about *præpostors* and *fagging*, in so far as the subject affects the health of individuals or schools. That it does affect the health—nay, the whole life—of a boy is beyond all question; and it is therefore, to my mind, a subject for very grave consideration. I am aware of the danger of saying a word about old institutions—and this prefectorial system is over five hundred years old—but I think the subject should be faced, and not shirked, so that we may obtain in this nineteenth century all the good out of it, and drop all the evil.

Now, I think there can be no shadow of a doubt that "sixth power" is an excellent element for good in a school when held by the right boy, with the right master over him. It is really a protection of the little boy from the bully (who is often one about his own size), for no one but the sixth form boy has any authority or power over him. It teaches the owner of the power manliness, self-reliance, responsibility, kindness of heart, and that mercy which "blesseth him that gives and him that takes." But when this power is possessed by a bad boy—and is there a master who has not had at one time or another such a sixth-form bully in his house, and yet has not deprived him of his power?—it is a great power of evil, and can be, I believe, the worst instrument of torture existing in our civilised Britain.

The power, if it exist—*as I think it should*—ought to be the reward of *character* more than of ability, and not of ability or place alone. By this means the muscular brute would be prevented from exercising his tyranny over his physically weaker school-fellow. Doubtless, the reason that "sixth power" is not taken from a boy who ought not to have it is because the stamp it would give the boy would be so bad that it would practically necessitate his removal from the school, which is a penalty too invidious to be put in force; but this is where the essence of the evil lies. "Sixth power," as the reward for being in the sixth, should not exist—it is wrong in principle, and occasionally the cause of untold evil where it is in force—but the prefect or præpostor system should take its place, and be the reward of character in the first place, and of ability as a secondary consideration. It should be tenable only from term to term, or during efficiency and good behaviour. At the end of each term the boy should give an account of his stewardship. If he has shown himself weak, incapable, or unfit to have the power, it should naturally fall through, without the invidiousness of dismissal; whereas, if he has done his duty, he would receive his office again next term.

Such a prefectorial system would make the power far different from what it is, and be an incalculable blessing to a school, by putting the right boys only in power; and the reward would be as great as it would be well-deserved, and would produce splendid fellows.

But while the present system of "sixth power" is in force, I think an additional protection to the boy should be instituted. Thus, where an offence against the properly-constituted authority of one of the sixth occurs, instead of this præpostor having the power to punish the offender forthwith, there should be a consultation of his colleagues in his house, not only to investigate the misdemeanour, but to punish it, and thus get rid of personal spleen and reduce petty tyranny.

One step further leads to *fagging*, and on this I have only one word to say: it may be a cause of ill-health in schools where the fag is kept employed at meal-times—say at breakfast, toasting—and so either is prevented from getting his own breakfast at all, or is obliged to bolt it because nearly all the allotted time for the meal has elapsed.

Punishments.—That the brutal, indiscriminate, and incessant caning of former years—giving vent to the spleen of the master—has gone out, and is the rare exception rather than the rule, is beyond question; and that it should be so is right, for it was exercised without any regard to the disposition of the boy or to his intellectual capacity, and without any mercy. It engendered terror and hatred in the sensitive boy, the "don't care" spirit in the average boy, and the dogged spirit of doing nothing in the bad boy, and gave exercise to his love of, and his desire for, revenge; it shut out all sympathy with the pupil from the heart of the teacher, and tended to do anything but heighten the character of either.

But, on the other hand, I do not believe that boys can always be controlled without occasional punishment. I do not think it a good thing for boys who need punishment to have a large proportion of their play-time taken from them to write —and spoil their handwriting—or to learn lines, when they should be out of doors getting exercise, and seeking and retaining health.

Sometimes, I think, a good birching or caning, when really necessary, would do far more good to a little boy, and yet allow him his legitimate time to take his exercise, have his freedom from restraint, and keep himself healthy; for it must be remembered that the naughty boy needs his time for recreation just as much as the good boy, if he is to retain health and strength.

When a big boy cannot get on and be managed without constant punishing, there is some gross fault somewhere; and if a change of masters cannot bring about a better state of affairs, as he is getting and doing no good, he should be removed from the school, for the sake of others.

But even the occasional birching and caning, which I cannot condemn, should be exercised with great judgment and long-suffering, lest a great wrong, never to be forgotten, may be committed. It is *sometimes* wrong so to punish: *often* wrong to withhold the punishment when deserved.

But there is another system of controlling boys, involving neither corporal punishment nor writing and learning lines. I refer to that wholesome satire which boys dislike so much, and which they would do anything rather than have to face, but which, judiciously exercised—so that it does not show a want of sympathy—is of untold value in keeping them under control. One of the best school disciplinarians I ever knew, and one who loved boys and was dearly loved by them, could keep his boys under control almost by this means alone. Where a master is honoured and respected by his boys—as he always should be, otherwise he has mistaken his calling —and they feel that his heart and sympathy are with them, they will strive to do right rather than incite his ridicule by their wrong-doings.

Rewards.—But beyond and above all punishments that are required in the management of a large number of boys, I would urge the plan of rewarding good conduct. Both plans are required, and answer, but the rewarding good conduct is, I think, the more salutary, and where it can be carried out will tend to promote the health and well-being of boys, and the happiness of masters. A kind word or a kind act, seasonably bestowed, will often win over a boy and make him strive to do right, when no punishment would have any effect on him whatever, and will make him feel that his master is not a slave-driver, but a kind and sympathising friend. Most boys—but not all, by any means—are like young animals: treat them kindly in breaking them in, and you can do anything with them; while the reverse system will show that they have a large share of obstinacy and carefully planned waywardness.

PLAY.

All the time that the boy is not at work, asleep, or feeding, should be spent in recreation of some kind. His recreation, or *physical education,* is scarcely second in importance to his mental development. And the first law at all schools—especially public schools, where more liberty exists—should be that games, which are the physical education of the boy, should be *compulsory,* so that he may be compelled to join in some games whether he will or not, while choice of other occupation during his leisure hours should be left to himself.

It must not be forgotten that the boy is an active animal, and unless he be kept employed at an innocent and healthy occupation during his play-time, which will allow the expenditure of his superfluous spirits and strength, he will not be idle—he is too restless a creature for that—but he will take up something probably not innocent, and not healthy, and become neither a credit to himself nor his school, but an evil-doer himself, and a teacher and example of evil-doing to others. The bane of every school is the "idle boy"—the boy who won't play: he is a constant worry to his master, being never out of mischief, a source of misery to himself, and very often a bully, having nothing better to do. Until parents see this for themselves we shall be ever having the constant outcry against compulsory games; whereas, it is this rule which is one of the chief sources of a healthy tone in schools, especially public schools. When this rule is abolished, our schools will become a source of evil in the country. Help boys to be manly, energetic, and enthusiastic at their games, and you help them to be healthy, ingenuous boys throughout their whole school life; fail in this, and you will have an unmanly precocity in self-indulgence, betting, smoking, and drinking, boys becoming premature "men of the world," and schools tainted with "society" which no master can control.

What can be better in schools than the healthy rivalry of sides at games, and of various houses, or schools, pitted one against another, every boy joining in the rivalry? The healthy and innocent ambition which makes one boy work to be at the head of his form, and excel in all he does at his work, also makes the same boy, or another, try to be at the head of one or of all his sports, whether football, cricket, or boating.

Some can excel in work, others at play; both should join in both, and be made to play as well as work. What is distasteful in work is not excused the boy: it is considered part of his education to do whatever comes before him; the same rule should exist in his physical education, and then what was distasteful originally may become a pleasure when it has been learnt and practised well.

The boy who does not join in games, but swaggers and lounges about, should be weeded out and got rid of, before he has a chance of corrupting others, through his idleness and the evil it engenders: the only ground on which a boy should be exempted from joining in the games should be physical incapacity or illness.

There are, however, few boys who should be thus excused, and then only after very careful examination and consideration: *e.g.*, boys with a phthisical history, those with mitral disease, those who have had recent serious illness, and those who have grown far beyond their strength; for these delicate boys, healthy and constant occupations during play-time can be arranged, such as gardening, carpentry, gymnastic exercises, music, art, drawing, and field excursions in botany, natural history, and geology.

But masters are continually hampered and hindered in carrying out these salutary regulations through physicians giving certificates to parents, stating that their sons are not fit to join in school games, often on the poorest pretexts, the physician little thinking the harm he does to the individual, and to the school on which he inflicts this idle boy.

This matter of compulsory games, I repeat, is essential to our having healthy boys in schools of a healthy tone, and the duty of the master is clear. He should permit no "loafer" to remain in his house; the sooner he is removed the better for all concerned.

The occupation for play-time, again, should be provided by the school for all weathers, so that the wet, as well as the fine, day may have its physical education, play, and pleasure.

In many of our oldest and largest public schools, regulations are in force as to the clothing that should be worn by the boys, both during school and play hours. With reference to the clothing for school hours I have nothing to say, further than what I have said should be provided for the boy on entering school; but I have much to say on the proper clothing for games, as it is a great source of health or ill-health, according as it is suitable or unsuitable. Boys should always have special clothing for all their games entailing exertion, not only that they may save their cloth clothes, but also that they may be clothed appropriately for playing, and may then have their dry clothing to put on again after the exertion; and the boy who is too lazy to change should be punished, for serious illness and death are sometimes occasioned through a boy playing in his ordinary clothes—say, at racquets—perspiring freely, and then standing about or lying on the grass in them.

The clothing for all games requiring any exertion, in summer and winter alike, should be flannel, and flannel only, and white flannel is the best of all; it is the best non-conductor, and also the greatest absorber of moisture. This flannel should be compulsory for all boys. Unfortunately, many injurious rules or customs in respect of clothing—originating, many of them, before medical knowledge had deigned to concern itself with such commonplace subjects—still exist in some of our older schools; for example, what can be more reprehensible, in relation to health, than the rule (unless it has lately been everywhere abolished) that the younger boys should in winter wear "white ducks" for football, and in summer appear in white linen or cotton shirts at cricket or boating, instead of flannel clothing.

Every now and then there is a popular outcry against exercise, and instances are quoted where harm has resulted. Now, this clamour should not be against exercise, but against *over-exercise*, or against ordinary exercise imprudently taken. It is excess of exercise which is deleterious to growing boys: it wears out and stunts; while exercise in proper measure produces health and strength.

Syncope, or fainting, in boys is usually attributed to over-exercise; but in my experience, while it may be occasioned by the physiological condition of the heart and vascular system at puberty, or be due to a temporarily dilated heart, from very active physical exertion in an unfit state of body, it is nearly always toxæmic —the blood being poisoned by the imperfect action of its excreting organs.

Games.—I must say a few words on the much-abused, healthy game of football; and the chief outcry, periodically raised, is against the game played according to what are called "Rugby Rules."

That accidents do happen at football, and when played under "Rugby rules," is beyond question. But to whom do they happen usually? Almost invariably to grown men who have lost their elasticity, who are out of training and flabby, and who have increased in weight and lost the old knack of playing. To these players it may be bad: that is, the good gained may not counterbalance the risk that is incurred; though of this I am not sure. But I trust the time is very far distant when football is to be removed from our schools as a winter game, unless some equally active and exciting game is to be supplied in its place.

I maintain that football, as played at our schools, by young, elastic, light boys, highly-trained, and always at it, is—where bear-play and the spleen of the bully are kept down by the conscientious reporting, without fear or favour, to head-quarters of all infringement of legitimate play—a great gain to all schools, and attended very rarely by accidents, and those seldom of a serious nature.

My experience does not enable me to recognise either the justice or prudence of parents in raising an outcry against football, as played at our schools. That it has its accidents, like, and not worse than, cricket, boating, and the gymnasium, and every other boys' game, no one will gainsay; but its good to boys far outweighs its evil effects, and all who know anything of it from experience, and not from hearsay, will admit this.

Private schools can organise their games to suit the capacity of the smaller boys; but the public schools, especially our great public schools (and this is one of the great benefits of large schools), should not only indulge in football, paper chases, cricket, and boating, but racquets, fives, and lawn tennis. There should be also a gymnasium to develop the much needed straight backs and round chests; a rifle corps, which affords such excellent training in exercise and skill as well as in discipline, teaching boys early that difficult but important lesson of acting together under leaders; "camping out," beneficial in every way when the corps is officered, as it should be, by conscientious masters; workshops, to develop mechanical taste, which is of value to all and of great value to many, besides being a boon on wet days; the useful and healthy swimming-bath; a library and art museum; natural history and debating societies; music, drawing, bicycle excursions, and gardening which could generally be easily carried out and made most enjoyable, especially for the delicate boys. Thus occupation would be provided for every boy of every conceivable taste in all weathers.

Boating is one of the very best exercises for boys, and every available piece of water should be made use of for the purpose, since it develops nearly all the muscles equally, making strong arms and legs, a well-expanded chest, and a straight, strong back. It is also good for the development of the heart and lungs when carried out with precaution; but I think it would be an invaluable rule to restrict it to those who take the trouble to learn to swim first; it would thus necessitate swimming, and would also be safer.

I would lay special stress upon the value of the swimming-bath and bathing. Every school that can possibly manage it should have a place in which the boys can learn and practise the healthy and useful enjoyment of swimming. If there be a river, it may be utilised, with advantage, for summer bathing; but it is not as good as a swimming-bath under cover, the water of which can be warmed, and so used all the year round. Swimming should be taught, if necessary, though as a rule nearly every boy will learn by himself or from his school-fellows.

The bath itself should be arranged for all sizes of boys, and there are two points about it which are essential :—

First, that the hot water should enter from the boiler to the bath at the *shallow* end, where the little fellows in learning to swim paddle so long in the water, so that they may have the benefit of the warmer water.

Secondly, that the *cold* water should leave the bath for the boiler from the deep end, and from the surface of the water; and that the *hot* water, which, as I have said, should enter at the shallow end, should emerge at the bottom of the bath, so that, being specifically lighter, it may rise to the surface, and thus warm the water throughout by its constant circulation while thus ascending. When the hot water comes into the bath at the surface, as is sometimes arranged, it simply floats on the top like oil, its heat only ascending and heating the building, while the water below is absolutely cold, often 15° Fahr. lower than that at the surface. This is not only a great waste of power in the heating arrangements, but it is positively injurious to swim in water hot round the neck and cold to the feet: occasioning in the young fainting, and tending to produce apoplexy in the middle-aged.

The temperature should never be below 65° Fahr., or above 70° Fahr.; for boys, winter and summer, generally stay long in the water.

ILLNESS.

The Malingerer.—All schools possess this creature, but he is found especially at the public schools, where he has increased opportunities for carrying out his inclinations, and great scope to practise his ingenuity.

There are two specimens of this class: first, the boy who has nothing the matter with him whatever, except that he dislikes work; second, the boy who has some slight discomfort, which he exaggerates when work has to be done, but ceases to remember when there is no work going on. These creatures—I cannot call them boys—are only seen on whole school days, or when the lesson is "unseen," but cannot be found when there is a half-holiday. I need scarcely say they do incalculable mischief to others, as well as to themselves.

This is not a natural production, but a carefully-manufactured article, produced at the cost of considerable ingenuity on the part of the malingerer, and considerable denseness on the part of the parent or parents, and being produced at home, wholly and solely by parents or their subordinates, is sent to school, to be a source of bad example to others.

Medical Arrangements.—In private schools, where there are only a small number of boys, the medical arrangements are, of course, the same as in a private family. The doctor is sent for when required, and the patient is nursed in the same way as is usual in private houses.

But in our great public schools a perfect medical organisation should exist—perfect in every detail, and capable of coping with any difficulty, small or great, not only for the welfare of the individual boy, but also for the benefit of the whole school.

To ensure this, there is one essential: there should be undivided responsibility; therefore, *one medical officer*, and one only; and the whole school should be under his daily supervision in medical and sanitary matters. He should be responsible to the head and house-masters for the whole arrangements for sickness and accidents occurring at school; he should regulate and control the entering, or return to, school of all boys who have been sick, or who come from houses where sickness has occurred in the vacation; and he should also, through the masters, advise parents of infectious illness that has taken place in the latter end of term, so that precautions may be adopted at home not to infect the family, and spread infectious illness all over the country from the schools as a centre. But while, in order to ensure efficiency, I would thus advocate undivided responsibility in carrying out the very important medical work in large schools, yet I would also urge that a *consultation* should be obtained without the slightest difficulty whenever thought necessary by a master or a parent, so as to prevent any possibility of arbitrariness.

It will thus be seen that the *duties* of the school medical adviser are fourfold, and of paramount importance. First, to treat accidents and sickness of all kinds; secondly, to have under control all sanitary arrangements in the school, boarding-houses, and sick-houses; thirdly, to prevent infectious illness entering a school, and to minimise it if it occur; fourthly, to protect parents from infectious illness being brought home from school.

To carry out his duties properly, a *daily attendance* is necessary. He should visit the whole school every day at a certain fixed hour, at a time when all the boys may be found in their houses; and the earlier in the morning the better, so that cases of illness and infectious disease may be at once weeded out from each boarding-house, and all malingerers sent into school. This medical visit should be made most punctually, for boys are boys, and if seeing the doctor entail the slightest trouble on them, they will not take that trouble to present themselves to him; but if they know that the doctor can be found at a certain moment, they may then condescend to show themselves to him. It is only thus that the fundamental medical rule for all schools can be carried out in any sense, and this rule is, "*Report yourself to the matron or doctor on the occurrence of the slightest ailment,*" for by this means alone can serious illness and epidemics be prevented. If the ailment be found to be *nothing*, the boy should be sent into school; if a *slight ailment*, he should be kept indoors, so that he may not get worse; if a *serious illness* be commencing, he should be immediately housed and taken care of, and placed under the most favourable circumstances for cure; if an *infectious illness*, the matron should at once isolate him until the doctor has seen him, and then, if there be a doubt, he should be *quarantined*, or if a certainty, he should be immediately transferred to the infectious house, and kept clear of all the rest of the school. This rule of early reporting of illness is absolutely necessary for the efficient medical government of all large schools. A great difficulty one has to contend with is the careless boy, who, knowing that he is not well, even having a *rash*, "thought it was nothing," and so risks the health and life of all his school-fellows.

In all schools there are a certain number of boys who, though not ill, are not strong enough, for the time being, to bear the usual school life, but need more home comforts and attention than can be provided where there are a large number. As far as I can learn, in no great school is special provision made for such delicate boys, although it could be easily carried out without trespassing on any vested interests, and with very great benefit to the boys themselves.

The class of boys for whom this provision should be made, in the shape of a *School Home*, includes young boys who are not naturally strong, but weakly, and who need care for a year or two at the commencement of their school life, before they are able to rough it amongst a large number; boys from a hot climate, who cannot bear much exposure for a term or two; boys who have had a recent severe illness, from which they have recovered, but who need some of the care of home life still for a term or two, the parents not wishing them to lose ground at school by being kept away until they can dispense with this additional care.

Such provision as I refer to could be carried out by a carefully selected junior married master; or still more appropriately, I think, by the medical officer to the school, where he is capable of managing boys, and could be induced to take them, as the boys would then be under constant medical supervision.

The sending of boys to this home should be entirely under the control of the head master, so that parents should have no voice in the matter, except through him.

Besides this, the fees would naturally make it prohibitive to any except those who *really* required the extra care. The number should be strictly limited—say, to ten—and every reasonable modern sanitary improvement should be provided, so that every boy would live in the highest state of health possible to be attained.

Provision for Sickness.—Every boarding-house in a large school has, or should have, a *sick-room*, where every boy who is not really ill, and yet not well enough to be at his work, should be taken care of, and be under the constant supervision of the matron, who ought to control all he does, and supervise his diet, which must be regulated by the medical officer, until he is again able to go into school. There should also be a night sick-room, in which a boy who is not quite well should sleep, in preference to his dormitory.

Should, however, a case of *infectious* illness be in the sick-room for even a short time—for instance, waiting for the doctor—the room should be thoroughly disinfected in some way before any other boy is placed there; which may be effected either by sulphur fumigation, or by setting free chlorine from chloride of lime by vinegar—a very easy and effectual process. The bedding, also, on which the infected boy has slept in the dormitory, should be removed and disinfected, and the dormitory itself should be well flushed with a cross draught of fresh air as long as possible, or, better still, be fumigated as above described.

Sanatorium.—Should a boy be really *ill* at school, he ought never, in my opinion, to be nursed at his boarding-house, for there are no proper arrangements there for sick nursing. There is too much noise and bustle, and no quiet can be obtained; every one is fully occupied with those who are in health, and his schoolfellows always want to go in to see him, which is very unwise where real illness exists.

Besides this, I think a skilled nurse alone should look after sickness, when boys have to be treated away from home. How parents like to treat their children, when ill at home, is one thing; but how schools look after them, when they are away from their friends, is another. There the most perfect arrangements should alone be in force, and the best skilled nurses alone employed, so that everything may be done, from first to last, for speedy and effectual cure. This rule is beyond question, and is, I believe, mostly, though not entirely, in force in all great schools.

A *sanatorium* or sick-house, therefore, is an essential, and should be provided for every great school, where all cases of *illness* and *accidents* should be treated. Here, also, may be admitted the majority of the *infectious ailments,* such as typhoid fever, diphtheria, measles, rötheln, mumps, chicken pox, and whooping cough, unless the school can—in some schools they are already in existence—provide two sick-houses (quite irrespective of the fever cottage for scarlatina), the one for accidents and non-infectious illnesses, the other for the slighter infectious ailments. I think one sanatorium is sufficient, provided there be great care and vigilance on the part of both doctor and nurse, especially if this sanatorium be constructed—as is the Rugby Sanatorium, which is quite a model—in three separate blocks of two floors, each block radiating at a different angle from a common hall, having a circular stone staircase in it, very spacious, and so well-ventilated as to be practically open at the top. Personally, I have never known a case of an infectious illness spread from one boy to another, or from one block to another, in this sanatorium; but, as a rule, cases of the various infectious illnesses do not very often co-exist, though, if they should happen to do so, one floor, or one block, may with care be safely used.

Fever Cottage.—For scarlatina (small pox is, or should be, out of the question at schools, where proper vaccination is carried out on entrance, as I have stated) it is safer and wiser to provide a special house or "*fever cottage,*" quite separate from the sanatorium, although under the supervision of the matron of the sanatorium when *not* in use; when it is occupied, it should be nursed and managed by a *separate* staff of nurses and servants, or helpers, holding no communication with the sanatorium staff.

After every case of scarlatina, it is important to disinfect the cottage as thoroughly as possible; just as if another case were never going into the building, in order that it may not always be a hot-bed of infection.

Quarantine.—All this "provision for sickness" is not complete—especially for scarlatina—without ample provision being supplied for the thorough *quarantine* of doubtful cases, so that, while every case, on the merest suspicion arising, should be at once separated from the school, it may not be transferred to the fever cottage until all doubt has vanished. I know of no more anxious and arduous duty befalling the physician to a great school than having to provide for several doubtful cases of scarlatina. To leave them in the boarding-house is wrong; to place them in the fever cottage is wrong; to put them all together in one room is wrong, for if one prove a case of scarlatina and the others are free, the latter stand the very greatest chance of having it through the exposure. The only proper and safe quarantine arrangement accordingly is, to place every doubtful case in a room by itself—using the ordinary sanatorium for this purpose if possible—for the few hours during which the doubt remains; then carefully to disinfect every room which has held a true case, and has thus become infected, before placing there another doubtful case.

By this strict isolation of all suspicious cases during their doubtful period from the very beginning, epidemics can be, and are, very much reduced, if not actually prevented.

Ambulance Carriage.—Every public school needs some mode of conveyance for the removal of sick boys unable to walk from the boarding-house to the sanatorium, but especially for infectious cases, for which the public conveyances ought never to be used. A properly-constructed ambulance carriage, drawn by a horse, is undoubtedly the best form of conveyance, which can, in the event of necessity, be transferred on to the railway, and so move a boy to the very door of his home; but inasmuch as it is only seldom required, it may be considered an unnecessary expense: the next best conveyance is a bath chair which will shut up, and can be washed and fumigated inside without damage.

Games for Convalescents.—A point not sufficiently considered in schools is the provision of occupation for those who have been ill, and have still to remain in the sick-house. Unless something be done for these boys, they are sure to get into mischief. Books are always provided for them; but boys cannot continue reading all day long, especially when their brains have wasted with their bodies during their illness; therefore, games of all kinds, both in-door and out-door, should be arranged for them.

Arrangement and Management of Sick-houses generally.—This is a matter of such paramount importance to the welfare of individuals, and the school itself, that it must be very carefully considered in every detail.

All arrangements in this world, of whatever description, when only required occasionally, are apt, unless very great vigilance be exercised, to be always out of order just at the very moment they are wanted for use. School sick-houses—which sometimes are not used at all for several weeks together, especially infectious sick-houses—are a very good instance of this fact. There is only one way of getting over this inconvenience, and that is, to have them in such order that they are always ready. To ensure this, a certain construction of the *warming apparatus* is necessary, and certain arrangements should be made, and rigidly enforced by the constant personal supervision of the medical officer, on whom the undivided responsibility should rest for the carrying out of every detail in the working. Thus, all sick-houses, of whatever description, should be provided with proper means for being always kept warmed and aired, either by hot water pipes throughout, hot air flues, or calorigens; besides having open fire-places in all rooms, for fires when they are occupied. In this way the whole house can be always aired and warmed by keeping one good fire going when the house is not in use; this fire should be always burning in damp weather, and lighted every other day in fine bright weather, except in summer, when it should be lighted on every day that is damp or without sun. On every suitable day windows should be open throughout the house, by which means the whole house will be well aired and purified. Also every now and then the water-closets and sinks should be overlooked and flushed when the house is not in use, though when the house-drains are properly cut off from the sewer, as they should always be, this is not of such paramount importance, as no sewer gas can enter the house.

I have many beds under my care, and so completely in working order are all arrangements that, from the day the boys return to school to the day they leave for the vacation, I can fill up any and every bed at any given moment without any other preparation than making up the bed or beds, and setting light to the fire in each room as required. By hot water pipes throughout both sick-houses the *rooms* are kept aired and warmed, and the mattresses, blankets, pillows, &c., also kept aired by being placed against the hot water pipes, or by very large hot water tins being folded within them for twenty-four hours each, in rotation. By this means of keeping sick-houses always in perfect working order they can be used in sickness with impunity, and by no other means can they be safely occupied when sickness occurs suddenly, as is generally the case. I have laid particular stress upon the importance of being thus ready for the sickness of schools, which is usually intermittent in character more or less, because sufficient attention is not, as a rule, paid to the matter in our schools, and often preparations are not made, nay, scarcely even thought of, until the illness actually occurs, which, to my mind, is too late, if we are to have our schools as healthy as they ought to be.

All rooms provided for sickness should allow at least 1,000 cubic feet for each non-infectious case, exclusive of the 800 cubic feet required for the nurse in attendance; but for infectious illness 1,500 to 2,000 cubic feet are essential, though more may be required if the case be severe or malignant, for such cases are generally much mitigated by an abundant supply of fresh air.

Besides this space, thorough ventilation must be given, free from draught. As a rule, the windows in the sick-room ought not to be opened during sickness, but the inlet for fresh air—which should be constant—should be from extensive and well-ventilated passages; for by this means the fresh air enters the room indirectly, instead of directly, and the patient is then less liable to draught than he would be if the window opened directly on to him in his room. Not only does this plentiful supply of fresh air benefit the individual, but in infectious illness too much stress cannot be laid on its importance to the community; for by it the poisonous element is more rapidly destroyed.

The temperature of the rooms should never be cold or hot; as a rule, 60° F. is about the average; though sometimes a hotter, sometimes a cooler temperature, is beneficial.

The walls of rooms for infectious cases should never be papered, but either painted, or covered with silica, which will wash with a disinfectant several times; or still better, made of Parian cement, which will wash *ad infinitum*, and to which nothing will stick. In rooms for non-infectious cases silica is good, and lasts well, even when washed several times; but colour wash may be employed, though in this case the walls need re-colouring annually, sometimes even oftener.

The floors of sick rooms should be stained and varnished; never washed, but wiped with a damp cloth every day when in use, and polished with beeswax and turpentine once or twice a week.

The furniture in all sick rooms should be only as much as is really necessary for comfort and convenience, and on no account should carpets ever be allowed; though mats may be used, the best being those made of cork, which will wash and are warm to the feet.

In all infectious illness—especially scarlatina—if a succession of cases occur and the same beds have to be used again, *a second case should on no account be put on the same mattress, or between the same blankets, until they have been thoroughly disinfected.* It is an infringement of this rule, I think, that accounts for the later cases being often more severe than the earlier ones; the rule, therefore, ought to be very closely observed and carried out under the personal superintendence of the medical officer.

If it be important in a boarding-house, as I have striven to prove, to have the drains properly constructed, with the soil-pipe thoroughly ventilated, and all drains cut off absolutely from the sewer, it is still more so at the sick-houses; for it is a serious matter to send a boy to a sanatorium for some comparatively trivial ailment, and to contract while there, through faulty drains, a dangerous disease such as typhoid fever or diphtheria.

Therefore, in towns all soil-pipes ought to be cut off from the town sewer, and in the country earth-closets should be used; or, if a cesspool exist, it ought to be far from the sick-house, on a lower level than the well, and it should be treated as if it were a sewer by cutting it off from the house.

Infectious Illness caught at School.—This may come from various causes, some of which we will enumerate, with their remedy.

SOURCE.	PREVENTION.
1. From the *town* and neighbourhood where cases may already exist.	1. Liberty, during play hours, is a rule at all public schools; and while there are "out of bounds" districts, the town is generally not forbidden, and I would not advise anything that would infringe this wholesome liberty of our public schools, so valuable a condition of their healthy life. Nevertheless, it is a constant source of infectious illness; but if ever a town epidemic prevailed, it would always be sufficient to tell the boys of it, and they would keep away without the necessity of putting the town "out of bounds": boys are always afraid of infection.
2. *Day scholars* may, and often do, bring infectious illness into school from an infected home.	2. As day scholars cannot be abolished, school authorities should encourage the greatest openness in such matters from parents, and be always on the alert, and equally open themselves in return.

SOURCE.	PREVENTION.
3. Infectious illness occurring among masters' or medical officers' children.	3. Such cases of illness in masters' or doctors' families should be most strictly isolated, or, better still, sent into the sanatorium or fever cottage, just as if they were pupils in the school itself; otherwise infection may be carried amongst the boys of a house or form. Masters' and doctors' houses should be above suspicion in such a matter.
4. From the *laundry*, which is a constant source of anxiety and doubt.	4. Where schools can, they should have their own laundry, as many have already; this is the only way to prevent infection from such a source.
5. From the *dairy*.	5. Every great school should have its own dairy; or be supplied with milk from *one* reliable source.
6. From the *sewers*.	6. The only security against this source of illness is to cut off the soil-pipe and house-drains absolutely from the town-sewer, as I have advised; to ventilate the soil-pipe; and to see that the town-sewer is thoroughly ventilated and flushed periodically. Parents should make all these necessary inquiries themselves, and should not leave them to chance.
7. *Cesspools* are one of the most fertile sources, and often cause the most dangerous illnesses.	7. Earth-closets should be employed in their stead; and if cesspools be used at all, there should be no possibility of their overflowing into a well; they should be cut off from the house-drains and well ventilated.
8. *Impure water*, especially when contaminated with sewage.	8. No well should ever be used in a town; wells in the country should be so placed and constructed that no surface-water can get into them. All water should be properly filtered.
9. *Railway journeys* to neighbouring towns for various purposes; and *exeats*.	9. These journeys, as far as possible, should be forbidden, as they are a frequent source of infectious illness being brought into a school; for other school reasons they should be reduced to a minimum if allowed at all.

The Prevention of Epidemics.—Epidemics in schools are such a serious matter, however slight the nature of the illness itself, that it behoves all concerned in the welfare of our schools to do their utmost in their prevention.

They sometimes either damage a boy for life, or cause his death; and they will make even an old and well-established school totter to its foundation, if they be severe or frequent. Therefore the question that concerns every one is, How are epidemics to be guarded against, and how can they be reduced in frequency and severity?

1. By *instant isolation* of the first and every succeeding case where the faintest reasonable suspicion can arise.

2. By perfect *quarantine* regulations and accommodation.

3. By perfect *disinfection* after the illness itself, or even the slightest exposure to the illness.

4. By plenty of *cubic space* to live in, and thorough *ventilation* as well, in all boarding-houses and class-rooms; so that disease germs may have no favourable soil in which to develop.

5. By efficient *drainage*.

6. By *pure water*.

7. By such a high condition of health in every boy that he will be less susceptible to the re-development of the poison.

Disinfection.—One of the most anxious matters to a private schoolmaster, and one of the greatest sources of annoyance to parents, is the period when a boy may safely return to school after an infectious illness has broken out at *home;* or when the boy may safely re-enter school, or go home, after an infectious illness has occurred at *school.* The time lost in every such case—waiting for this freedom from infection—is irritating in the extreme to all concerned; the parent thinks he is paying his money for a thirteen weeks' term, and finds six weeks of it lost through his son not being free from infection, and therefore unable to mix with his school-fellows; the master is annoyed at the boy not only losing his time and his position in the school, but also at his becoming demoralised in consequence of his comparatively enforced idleness; the boy himself is sickened and disheartened with his imprisonment and isolation: so that all suffer.

Now this anxiety and annoyance can be very much mitigated, indeed almost obviated, at all great public schools, by the provision of a good and easily workable *disinfecting apparatus.* It will be found one of the greatest boons to parent, master, doctor, and patient.

There are several forms of this "Disinfecting apparatus" in use at the present time all over the country. They are made to be worked with either gas or coke, gas being far more easily managed; this, of course, also adds very much to their efficiency, which is no small item in carrying out such a matter properly. The most perfect one, I believe, is the "Nottingham Self-Regulating Disinfecting Apparatus," but Nelson's, of Leeds, is a cheaper one, is trustworthy, answers admirably in every way, and is the one I myself use.

The *heat* is raised until the thermometer registers a minimum of 140° F. outside—inside the heat being about 60° F. above this, or 200° F.—and it may range from 200° F. to 250° F. inside without damage to articles of clothing or bedding. It takes about twenty minutes to get thoroughly heated for use; and in this chamber every soiled and infected article can be rendered free from infection within a reasonable time—from twenty to sixty minutes, varying according to its size, material, and thickness. I have never known a case of infection occur through imperfect or ineffectual disinfection by this hot-air process. Thus mattresses, pillows, &c., take about three-quarters of an hour to an hour to become thoroughly purified, and every mattress that is ever required for a second case, even of the same infectious illness, should be thus purified and rendered free from infection before being used again.

Of course all clothing that will wash should be washed; but all articles that cannot be washed can yet be rendered perfectly safe from infection; and thus the gain is incalculable.

The benefit obtained at schools by this apparatus for the disinfection of the clothes and bedding of every case occurring at school is palpable to all; but there is another gain, even greater, involved in the use of such an apparatus, on the re-assembling of all schools after the vacation. I shall explain myself best by stating cases, which will be more readily followed.

First, let us take an example of an infectious illness arising *at school.* A boy has, say, measles; as soon as the illness is over, and he has been up and out of doors for several days, he can be washed all over with carbolic soap. His clothes can then be passed through the disinfecting chamber, and he can return to school safely. Also his mattress and bedding can be rendered quite free from danger, and ready for another case should occasion require.

If I now state what used to be the process followed, the gain obtained will be clear. After every case of infection, however trivial, the clothes had to be disinfected as best they could, by sulphur fumigation and washing, or else a farm had to be found in the country, after a great deal of trouble, and there the boy was sent for as long as was necessary, according to the nature of the attack and of the illness; his bedding had to be soaked in a disinfectant, which damaged it, or else it was sent to an upholsterer to be taken to pieces and thoroughly disinfected, at considerable expense.

Secondly, let us take three examples of infectious illness occurring *at home* during the vacation, and see how this apparatus serves us.

1. A boy has measles in the vacation. The illness is over, and he is ready to return to school; but he comes from an infected house, and his clothes are saturated with poison. What is to be done to protect the school from the admission of such a poison?

Instead of having to send him away from all source of infection for a time, he can—after home disinfection—come at once to the school sanatorium, and there be thoroughly disinfected, and then enter his boarding-house without danger to any one.

2. A boy's sister has scarlatina. He himself has had it at some previous time, but he has been with his sister, or mixed with those who have been in the sick-room; and although there is little chance of his having it a second time, yet his clothes are infected. How is the school to protect itself? Instead of sending him right away from all chance of infection to purify his clothes, he can come to the school sanatorium to be disinfected, and then enter his boarding-house with safety to all his school-fellows.

3. A boy's brother has scarlatina. The boy himself has never had it, but he has been with his brother; therefore, is he already infected? is he incubating it and going to have it himself? In this case, he ought to leave the house and all chance of infection for eight clear days; then, if he show no symptoms, he may be disinfected and return to school.

This disinfecting apparatus has proved, together with other precautions, an immense boon; for the greatest period of anxiety to all schools is the first ten days of term. Where boys come from all parts of the country, the question is, What have we had brought back to school?

But for schools which have no disinfecting apparatus, certain rigid rules are a necessity, before a boy can enter or return to school, for the preservation of the whole school. This involves the "duration of infectiveness," which we shall consider presently.

Convalescents.—In all infectious ailments, after the illness itself is over, if only *a case or two* have occurred, they may be retained in the sanatorium until fit to go home or to return to school, provided always a sufficient time has elapsed, and efficient disinfection of clothes has been carried out; and as no case would be permitted to re-enter school until perfectly safe, so no case should ever be allowed to travel in public conveyances until free from infection.

But where *many* cases occur following each other rapidly, the beds are required for fresh cases; and as one batch is convalescent it should be removed, and the rooms and bedding disinfected before being re-occupied by another batch. The question—Where are they to be removed to? is often one of very great difficulty and anxiety. Of course, not one invalid must be touched on any account until he himself be perfectly safe for removal—nay, more, until removal would be beneficial to him other provision must be made. Personally I have, though sometimes with great difficulty, been always able to find a farm, situated quite in the country and away from all houses, kept by a farmer and his wife (who should be a trustworthy, motherly woman), without children. Here we send boys as they are ready, and they eat, drink, sleep, and enjoy themselves beyond measure, and are generally loth to leave.

Breaking up a School because of the Advent of Malignant Infectious Illness.—This question may at any moment arise at any school, and require a quick and judicious decision on the part of the authorities.

If a single *malignant* case of infectious illness occurs in a school, I think it is the duty of the medical officer to acquaint the head master of the fact at once, warning him that it may be the nature of the poison—malignant—which has caused it, though it may possibly be only a *mild* poison, severely poisoning an individual, owing to his idiosyncrasy. But should a second case arise, I think it his duty to clearly lay the matter before the head master in a form beyond misconception, for the blame rests on the medical officer if he do not, or if he be in the least ambiguous.

Then the head master can, if he think well, give all parents, *whose sons have not had the illness previously*, the opportunity of removing them if they wish; but I think no school should ever be broken up and the boys forwarded to their homes, where, perhaps, there may be a large family of young children, whether the parents wish it or not. The illness was developed at the school, and the authorities should make all necessary provision for its treatment; and the onus of removing a boy from the school at all, and perhaps giving the illness to other children, and spreading it in all parts of the country, should rest with the parents, and not with the school authorities.

All boys thus removed should take home a certificate, acquainting the parents with the period of incubation of the illness, and how long the boy should be kept apart, and when he may, without danger, mix with the other members of the family.

The Prevention of Infectious Illness being taken Home from School.—As it is the parent's duty to see that infectious illness is not taken from home to school, so it is a master's duty—equally important—not to allow infectious illness to be carried home from school; he should therefore inform parents when infectious illness has occurred towards the end of term. Of course, no boy who had had the illness would be allowed to go home until he was perfectly free from infection and able to mix with others. But I am referring to a boy who may have caught the illness, which is incubating in him, and which will show itself at its natural time, but who, to all appearances at the time of leaving school, is quite well, and may continue so for many days. The parent, not knowing what is likely to occur, makes no preparations, may be going to travel with his family abroad, and may be miles from all medical assistance, and then find to his cost that he has been carrying an expensive and deadly enemy with him on his holiday trip.

Such a possibility should never be permitted to occur. Every parent should always be informed by the master of the fact, and so warned in time of what may be going to happen. Every master, therefore, when such infectious illness has occurred near enough to the end of term for a boy to show it after leaving school, should forward to the parent a form of certificate, warning him that his son may show a certain illness within a specified date—if he have not already had it—and so allow him to use precautions to protect his other children and his friends.

The Prevention of Infectious Illness being taken from Home to School.—Such consideration and care as I have indicated above, on the part of the school authorities, will cause parents to be more careful and conscientious on their part, and then schools will not be in such a state of anxiety and suspense for the first few days of term, on account of the possible importation of infectious illness.

But it is necessary and very important for schools to protect themselves still further; for we sometimes have careless parents to deal with—parents who do not mean harm, but who do incalculable harm.

I therefore think every school, public and private, should supply a form of "certificate" to every parent, to be brought back, signed by the parent, when the boy returns to school; and if he return without it, he should be kept separate from his school-fellows until it is obtained, or until the telegraph has been set to work to get a satisfactory answer.

But I do not think it is reasonable or fair, as is sometimes done, to compel a parent to go to the expense and trouble of obtaining the signature of his medical adviser to a document that a parent can sign himself as efficiently and truthfully. The form of certificate might be as follows :—

THE PREVENTION OF INFECTIOUS ILLNESS AT SCHOOLS.

Obverse.

There have been the following cases of infectious illness in my house during the vacation :—

1. Nature of illness.
2. Date of commencement of last case of the illness.
3. Precautions that were taken.

Name. Name of school.

4. My son.........................., who is at school at........................., has or has not had this illness.

(Signed)

Parent or Guardian.

This should be posted to the Master a week before the return of the boy to school.

THE PREVENTION OF INFECTIOUS ILLNESS AT SCHOOLS.

Reverse.

There has not been a case of any infectious illness in my house during the vacation, nor has my son, to my knowledge, been in the way of any infection.

(Signed)

Parent or Guardian.

This should be posted before the boy returns to school, or sent with him.

Incubation Period of Infectious Illnesses.—My information and guidance to masters and parents, in all that relates to school infectious illnesses, will not be complete unless I give a clear statement of the "periods of incubation" or latency of such illnesses—*i.e.*, the time from exposure to the manifestation of symptoms. And by so doing, much annoyance to parents will be obviated, because they will then know the natural history of infectious seeds, and will understand better that these seeds have a time of development of their own, as every other seed in the world has; and that all that is required by school authorities is an observance of the periods of development of these seeds or germs, for the good of the school, and the preservation of the health of all the boys in it.

The following table will serve as a rough guide, but all points in which a doubt can arise should always be referred to the medical authority.

INCUBATION.

Name of Illness.	Most commonly.	But has this range.	Remarks.
Scarlatina . . .	4th day	1—7 days	
Diphtheria . . .	2nd day	2—5 days	
Small-pox . . .	12th day	1—14 days	
Chicken-pox . . .	14th day	10—18 days	
Typhus fever . . .	12th day	1—21 days	
Enteric fever . . .	21st day	1—28 days	
Measles	14th day the eruption appears	10—14 days	Infectious during the catarrhal stage, three days before eruption appears.
Rötheln, or Epidemic Roseola .	14th day	12—20 days	
Mumps	19th day	16—24 days	
Whooping-cough . .	14th day	7—14 days	Infectious during the primary cough, which may be three weeks before the whooping commences.

Duration of Infectiveness.—In the present state of medical science this question cannot be definitely settled, for we do not possess sufficient accurate data on which to base our opinions, the facts on which to obtain a certainty being very difficult, if not impossible, to get; but, for all practical purposes, we must form some provisional rules to guide our conduct.

The practical question is this: a boy having had an infectious illness, when may he rejoin his school-fellows? or when may he safely return to school from home? or, when may he be allowed to go home? Under this section we only consider the question: *When a boy has had the illness himself, how long does he continue infectious?* All other matters have been previously discussed. I think the following table will most accurately give the requisite information.

TABLE SHOWING DURATION OF INFECTION.

Name of Illness.	Period.
Scarlatina . .	The boy may enter a school when all desquamation has ceased—*i.e.*, in from five to eight weeks. This is the only safe rule to act upon at the present time in the management of schools, for it is impossible to say accurately when the contagion ceases.
Diphtheria . .	,, ,, after fourteen days, or as soon as his strength allows.
Small-pox . Chicken-pox .	,, ,, when every scab has fallen from head and body.
Typhus Fever Enteric Fever	,, ,, when strength has sufficiently recovered to allow it.
Measles . . .	,, ,, when all desquamation and cough have ceased—from two to four weeks.
Rötheln, or Epidemic Roseola	,, ,, ten to fourteen days from the commencement, according to the nature of the attack.
Mumps . . .	,, ,, fourteen days from the commencement.
Whooping Cough .	,, ,, when cough has quite ceased, or else six weeks from the commencement of the whooping.
Ringworm . .	,, ,, when all active growth has ceased; but even then he should be under daily medical supervision for a week at least, and at intervals subsequently.

This table, however, has been compiled on the assumption that the school authorities protect themselves concerning the boy's infected skin and clothes. It is of no use whatever trusting to parents, for they are not responsible, and the responsibility of sending infection amongst several hundred boys does not seem to weigh with them as it should; and, while one parent is very careful in every detail, another is just as careless. Accordingly, when there is the faintest suspicion that a boy is infectious himself, or has even come from an infectious house, he should not be allowed to mix with his school-fellows until a responsible school authority has washed him thoroughly from head to foot with disinfecting soap, and fumigated every article of clothing with sulphur or chlorine—or, still better, until every article has been passed through the disinfecting chamber.

I believe most firmly that *all* our infectious ailments are communicated by the clothes of persons visiting those infected; but whether this be endorsed by others or not, it is the only safe rule to act upon in the management of great schools. That some of them are thus communicable, all will admit, but that some may not be may be an open question. It is, however, childish to see how near we can go to fire without burning our fingers; and where the life and health of a great school are concerned, we should keep as far from any chance of infection as possible, and regard every one coming from an infected house as *not* being above suspicion, and act accordingly. Therefore all boys coming from an infected house should be always disinfected by the school authorities; for the neglect of the disinfection of the most insignificant article of wearing apparel may be the occasion of an infectious illness, and be the starting-point of serious mischief.

It is, I think, incumbent on all schools to make the most stringent rules for their self-preservation from infectious illnesses; but these rules should be founded solely on the natural history of the infectious diseases, and should be neither mere whims nor arbitrary laws, but as true to accurate facts as medical science at present permits.

Self-regulation of Health.

If we are to have good, strong, healthy boys while they are at school, free from acute serious illness and chronic ailments, not only must schools provide for them all that I have previously advised, but the boys must also be taught how to manage themselves. Much can be done for them by the occasional guidance of parents and masters, and much can be effected by an appropriate word in private; but the boy cannot always have some one at his elbow to guide him, and therefore he will have to learn to manage himself properly, according to his constitution, and to find out that Nature will not suffer any infringement of her laws with impunity: an experience only gained after many serious trips.

And (1), he should learn to manage his *stomach;* to observe what he can eat and what he cannot eat without discomfort; to recognise that it is not wholesome to eat what disagrees with him, and that a frequent repetition of the error will either make him ill soon, or will tend to disease when he gets older. It is unhealthy to eat or drink between meals: therefore what pastry and sweets he desires should be taken immediately *after* a meal, and not between meals; for they upset the stomach—which requires rest between meals—and prevent his eating his staple food. Also, that to enable the stomach to digest its food, active exertion should not be undergone—certainly not within an hour and a half after eating.

(2) He should be taught how very important it is, while he is young and active, to have his *natural relief* every day, without fail, at the same time—not only for his present health and comfort, but also to obviate a tendency to disease, which a neglect of this precaution entails in after-years.

(3) It is most important for him to see that the *feet* are kept warm and dry, and that boots should be made to fit accurately, so as to prevent chilblains and other discomforts and deformities.

(4) Too much cannot be said concerning the *skin*, for it is a very important gland of our body and needs considerable care. It should be always kept clean and sweet, so as to enable it to act at the greatest advantage; it should be covered with flannel to keep it warm, to absorb its moisture, and to prevent sudden changes of temperature affecting its continuous action. Therefore, for active exertion which

will cause the skin to perspire freely, *special* flannel garments should be provided which will absorb the moisture during the exertion, and allow the ordinary garments to be put on afterwards in the place of those which are damp from the exercise. It is unwise to stand about or lie on grass when the skin is, or has been, perspiring ; but every effort should be made to encourage the skin to cool gradually, a feeling of chilliness being a sure sign that it is cooling too quickly, and that exercise, or another coat, is required.

(5) It is not dangerous to drink while hot, provided the liquid be taken in sips, but the danger lies in drinking a quantity of cold fluid, which is very injurious indeed.

(6) When not feeling quite well, and disinclined for food, it is best to abstain from food altogether for a few hours, and he will then right himself; but it is unwholesome, when unable to eat his ordinary food, to go to the pastry-cook, or hamper, and eat dainties, and so make himself worse.

(7) Boys should make a good meal at tea-time, and avoid any food afterwards, unless it be a little milk and bread-and-butter ; but they are better without anything, for they will sleep more quietly and comfortably, and awake far more vigorous in the morning.

(8) Very strongly indeed would I urge upon boys the necessity, from a health point of view, of accustoming themselves to sleep as cool—not cold—as they can at night : it tends to health and vigour, and to purity of thought and conduct.

(9) Exercise is the great remedy to keep down excess of animal spirits.

(10) A cold bath should be taken every morning.

Day Scholars.

There is much to be said for and against the day-school system. To some boys it is an incalculable gain to be able to go to a good school, and yet to reside at home, and have the benefit of home influence, home comforts, and the society of mother and sisters; while to others it is the worst thing that could happen to them, for they never develop into men at all, but are babies all their lives.

On the whole, I think, it will be generally admitted that it is the greatest gain for nearly every boy to go from home to school; for his work is done better, and he learns that most wholesome lesson—which should be learnt early in life—to find his own level; he there finds also that good feeling of comradeship which is salutary to every boy throughout his boyhood and in after life; as well as that inestimable boon of staunch friendship which often lasts as long as life itself.

To the few who obtain nothing but harm from being away from home at school, and to some delicate boys, the privilege of being a day scholar at a good public school is very great.

I must, however, not consider the boys only, but the effect on the school itself where these boys are admitted. Where the parents are high-principled people, and uphold the school authorities as they should, and conform to school rules to the very letter, day scholars are a source of good to the school by the influence they exert on the boy and his school friends who visit at his house; but where the parents are the reverse, and allow laxity in the boy's conduct, and in his observance of school rules, they may cause much mischief to the general tone of the school.

Another great disadvantage which must not be overlooked is, that day scholars may bring infectious illness into a school unless very great vigilance and circumspection be exercised both by parents and school authorities.

Girls' Schools.

The general education of English girls is still so defective in principle that it is almost inconceivable that it should be in its present state—quite fifty years behind the education of boys.

Notwithstanding this, however, as far as I can learn, our girls' schools are quietly and unostentatiously making great strides in their improvement; but I would I could see the alteration in their education that is requisite. Much, if not most, of what I have said in these pages relates already to girls' schools, or should do so, and will do so, I trust, in time.

The *great defect* in most schools for girls is the utter neglect of *physical education;* whereas it should have *prior* claim to their intellectual education, if there be any difference made at all. We need strong, healthy, vigorous women, and not fragile, fainting, insipid creatures; and yet no attempt is made to produce them, during the only years in which they can be produced—viz., their active years of growth and development; their exercise usually consists only of a stately walk in the street, weather permitting; dancing, calisthenics, and deportment once a week; sometimes lawn tennis. Such neglect should not be. It seems to me the very way to produce *girls* who are useless as companions, *wives* who live on a sofa, and *mothers* who are unfit for their duties. Besides, if greater pains were taken to make vigorous bodies, we should have more vigorous brains, so that a double gain would result.

Another point is, the neglect, as a rule—happily not without exceptions—of the morning cold bath for girls; and yet there is nothing that so tends to create health and strength, to say nothing of cleanliness. What is provided instead? A warm bath once a week.

It must not be forgotten that girls are naturally more subject than boys to nervous excitement, which could be kept more under control by a better physical development. Because of this nervous condition, I think competitive examinations for girls, as a rule, are bad. Witness the terrible breakdowns the physician so often sees resulting. If this age be one in which young people cannot live unless they are competing, let us err on the right side, and let our English girls be taught to excel in every womanly exercise, in preference to nervous excitement, and a preternatural development of the emotions. But why are our girls what they are? Some of them nothing but nerves, others nothing but emotions, others ready to faint on any or without any provocation. They are simply suffering from their faulty education, their narrow mode of life, and their preposterous nineteenth century dress. We want more muscles and less nerves in our girls, if we are to have them healthy and vigorous.

Another great defect in the education of girls lies in the excess to which the practice of requiring lessons to be *written out* has been carried; for with improper seats, unsuitable desks, and imperfect light, the pupils get so fatigued that they lounge over the table in consequence, and a curved spine and prominent right shoulder result. In fact, it is difficult to find a girl without an abnormally curved back, one-sided shoulders, and a prominent shoulder-blade. But this is not entirely owing to the above cause; it is partly due to the artificial support—stays—to the spine during the growing years, and the general constraint of the modern dress preventing the muscles having good healthy work to do, and thus being made strong and capable; instead of which, the muscles of the spine not being allowed work become weak and flabby, and quite incapable of supporting the trunk in the upright position. Is it possible that it is necessary still to teach that muscles to be strong and vigorous must have sufficient exercise? The spinal muscles of the girl waste, and so allow a spine to become deformed, because the spinal muscles are incapable of their required exertion. The *high-heeled boots*, too, not only cramp the feet, but deform them, and the spine and pelvis as well—an effect which cannot be too strongly deprecated in growing girls.

CONCLUSION.

I am sure all will admit that school life should be perfectly happy and healthy—the happiest and healthiest in one's life. In these pages I have endeavoured to set forth how this health may be attained.

In considering the whole life of a boy at school, from the time he enters to the time he leaves, I have—though imperfectly I feel—tried to show what tends to increase and what to deteriorate health, what surroundings he should have to obtain the highest state of health, and what may be the causes of disease, near or remote. I have also endeavoured to show that if there be one thing worse than another for any boy, one thing more detrimental to a whole school than another, it is for a boy to be placed under the care of a master at school who is lax in his discipline, and who cannot manage his boys. As a friend of mine has very aptly put it: "A good disciplinarian is not a man who punishes disorderly boys; he is a man in whose presence boys never think of being disorderly," for the boy has simply the greatest conceivable contempt for a master who cannot manage him, and there is no severer critic on earth than a public school boy.

If we are to have good boys, we must have masters—as we mostly have already—who can command the respect of their boys; who can, without fear or favour, crush the wrong, and uphold all that is manly and right, and thus win the heart of the boy.

Faithfully I have tried to depict—from the physician's point of view—what should be and what should not be in schools. Our schools are none of them perfect, and they vary very much, some being years behind others in medical and sanitary matters. Also I have striven to point out, not only how parents may send forth from home—and masters from school into the world—healthy boys, but also manly, generous, upright ones, able to withstand temptation, and willing to do their duty wherever and whatever it may be.

THE EYE AND SIGHT.

By Henry Power, F.R.C.S.,

Ophthalmic Surgeon to St. Bartholomew's Hospital.

The Value of Good Eyesight—Structure of the Eye—Functions of the Eye—Power of Accommodation—Presbyopia—Acuteness of Vision—The Field of Vision—Colour-Blindness—The Effects of Variations of Light and Temperature—The Care of the Eye in Infancy—Purulent Ophthalmia—Long-sightedness, or Hypermetropia, and the Prevention of Squint—Myopia or Short-sightedness—Ulcer of the Cornea—The Care of the Eyes in Middle Age—Injurious Influences of Tobacco—The Preservation of the Sight—Nature and Prevention of Cataract—Protective Apparatus of the Eye.

The value of the sense of sight is so great, the variety, extent, and importance of the knowledge it affords is so much larger than that supplied by the other senses, that its loss, or even impairment, is always acutely felt. Young and old, rich and poor, are equally interested in its preservation, for its failure places the sufferer at the mercy of others, renders him more liable to accident, more open to deceit, and, as a rule, unfits him for the discharge of the more active duties of life, or, at least, enables him to perform them only at a great disadvantage to the rest of mankind. The rich man may indeed substitute the eyes, the hands, and the voice of others to assuage his affliction, to inform him of what is passing around him, and to protect him from injury; but he loses all those uncommunicable charms, both of nature and of art, that his higher culture fits him to appreciate and enjoy, and that are yielded by form, colour, movement, and expression, by the play of light and shade, and the infinite variety of visual sensations. The poor man suffers still more acutely; for, unless endowed with more than common energy, he feels that he has lost the means of subsistence, and that he has become a burden on his family, whilst he is at the same time destitute of those resources which are afforded by memory and reflection.

The greatest of our poets supplies those touches that make the whole world kin in the pathetic scene in which Arthur pleads to Hubert for his sight; whilst he depicts the utter helplessness of the blind in making Gloster, the statesman and the courtier, dependent for his guidance on poor mad Tom. Even Milton, who might have been expected to have found in the resources of his richly-endowed intellect and well-stored memory all the alleviation that knowledge and learning and piety could give, sometimes bewails his condition in tones of unmitigated grief, and regards it as the consummation of human misery to be blind amongst enemies; and although at an early period of his affliction he could write to his friend Cyriac, "I argue not against Heaven's hand or will, nor bate a jot of heart or hope, but still bear up and steer right onward," it is not possible to read the numerous passages in which he refers to his calamity without perceiving how keenly its loss was felt, whilst the frequency with which he reverts to it shows how constantly it was present in his mind.

The possession of good vision is of immense importance in the early years of life.

The receptive faculties of the brain are then in their highest state of activity; impressions are then received and images stored up which are never acquired with equal sharpness in after years; and if the vision at this period be seriously impaired the whole system of education, as usually carried out in this country, is practically stopped. Indeed, it may be said that in some respects, so far as education is concerned, a child that is absolutely blind is in a better position than one whose sight is seriously impaired. The blind child, though wisdom is at one entrance quite shut out, is yet encouraged to the exercise of his other senses, which acquire, by constant practice, a marvellous acuteness of perception—an acuteness that enables them, to a large extent, to supply the place of that which is wanting. The blind child's education, in one or other of the numerous blind-schools scattered through the country, is systematic and continuous; and, upon the whole, his life is happy and enjoyable. But it is otherwise with the child who has only impaired vision. Months and years are often allowed to elapse in the hope, not always realised, that improvement will take place, that he will some day be able to receive an ordinary school education and acquire the common information that children possess; and in the meantime, left to himself, and neglected at the most critical period of his life, he grows up ignorant of the rudiments of knowledge; and if, as time passes on, he is fortunate enough to recover useful vision, he still finds himself placed at an immense disadvantage, as compared with those around him who can see well.

The importance of sight in mid-age need not be dwelt on. It is equally valuable and essential to the bread-winner and to the mother of the family. Nor is good sight less valued as age advances: nay, it is perhaps then most appreciated. The merchant, the barrister, the physician, or the soldier who has attained the highest rank in his business or profession, is, with failing vision, instantly made sensible of the precarious tenure of his position: instantly feels that the active work of his life is done, and that even if, by surgical measures or medical advice, his sight can be restored, others will have, in the meantime, stepped into his vacant place.

It may be remarked in passing, that the eye is an organ that has undergone evolution as the result of the action of light upon the body; and that when light is withdrawn it gradually wastes, and at length wholly disappears. Every form of animal life is susceptible to the action of light, but in the lowest forms no special organ is developed; the surface of the body generally responds to it. In animals very low in the scale, however, one or more—sometimes very many—parts of the body become coloured; and as the scale is ascended, whilst the number of these is reduced, fresh structures are added, each giving its possessor an advantage in the struggle that is always being waged for existence; till, at length, the complex eye of the insect, the bird, and mammal is reached. When light is feeble, as at great depths of the ocean, the eye sometimes becomes of portentous size, clearly with the object of gathering in all the rays that penetrate those dark regions. But if the mode of life of the animal be such that it is seldom or never exposed to luminous rays, one by one these parts waste away, the whole organ becomes more rudimentary, and at length entirely disappears. The mole, the proteus which inhabits the subterranean streams of Styria, and the eyeless insects and even spiders of the caves of Kentucky, show how, by disuse, the process of degeneration advances, till at length even predatory animals have to depend for their sustenance on other senses which there is every reason to believe have, in the course of ages, undergone a correlative increase in acuteness. Such slow changes may be and are actually in progress without extinction of the race; but it remains no less true that loss of vision effected in the lifetime of the individual is always disastrous, and, in the case of the animals below man, is practically fatal; for an animal thus afflicted is not only incapable of obtaining its own food, but is immediately exposed to the attacks of others, to which it soon falls a victim.

Sight having thus been shown to be serviceable to all, and indispensable to the great majority of animals and of men, it is obvious that a knowledge of the means by which it may be preserved, and by which injurious influences may be avoided, should form part of general information; and it is the object of the following pages to supply some rudimentary instruction on these points, and thus to assist the generation that will follow us to succeed to a thoroughly healthy organ, which may enable them to pursue their avocations without fear or anxiety. That such knowledge is of real value cannot be better demonstrated than by a reference to the German race of the present day, in which short-sightedness has become a national evil of great magnitude, the causes of which have only recently begun to be understood, but which have attracted an extraordinary amount of attention, leading to the adoption of many improvements in the system of education hitherto pursued

The Structure of the Eye.

Before entering into any details as to the best means of preserving good vision to an advanced period of life, it will be expedient to give an account, though it must necessarily be very compressed, of the structure of the eye: to show how it is protected, how moved, in what way the image of the outer world is formed on the retina, and what are the arrangements by which we are enabled to adapt our vision for distant and near objects respectively. The diagram showing a section of the eye (Fig. 1) represents the principal points to which reference will be made.

The human eye is a nearly spherical body, about one inch in diameter, occupying the fore part of the hollow of the orbit, by which it is enclosed on every side except in front. It is kept in position by various muscles and blood-vessels, and by the optic nerve (O P), which conducts the impressions made upon the retina to the brain, and which is attached to it behind, a little to its inner side.

The eye is remarkably protected from injury. The bones of the nose, of the brow, and of the cheek collectively form a kind of outwork, defending it from direct blows of all rounded or blunt instruments, unless directed with extreme violence. It rests upon a bed or cushion of fat, which not only facilitates its movements, but permits it to yield to pressure of moderate degree. The acute sensibility of the eyelids and of the lashes with which they are fringed enables the approach of small objects, such as insects, to be perceived in time to close the lids, and thus prevent their entrance. The eyebrows turn the drops of sweat by which man has to obtain his daily bread to the side, whilst the discharge of tears excited by any irritation applied to the surface of the eye protects it from the harm that might result from the entrance of dust, sand, or other objects borne on the wind, which, though too small to be seen and avoided, are yet capable of producing much discomfort, or even of exciting acute inflammation. In addition, the rapidity with which movements of the head can be made in response to impressions of sense enables us in many instances to escape danger to the eyes which would otherwise be inevitable. Each eye is moved by six muscles, which are attached to it in such a manner that they can roll it in any direction; and the movements of the two eyes effected by these muscles are amongst the best examples of harmony and co-ordination, or concordant action, of muscles in the body, the least deviation from absolute symmetry being productive of double vision. Four of these muscles are named the straight, or recti, muscles, and turn the eye upwards, downwards, inwards, and outwards; whilst the two remaining ones, named the superior and inferior oblique muscles, respectively roll the eye downwards and outwards, and upwards and outwards, besides slightly modifying the action of the straight muscles. In many animals, as the sheep, ox, and horse, an additional muscle, the retractor of the eye, is found, the use of which is to draw the eye back into the socket, and thus more effectually to protect it in plunging through thickets or in the fights to which the males are prone. In front, the eye is covered by a delicate membrane, named the conjunctiva. This membrane forms the soft velvety layer that lines the lids, is reflected from them to the white of the eye, and extends in the form of a very delicate and transparent layer of cells over the cornea, or glass of the eye. The smooth, moist, opposed surfaces of this membrane, which are constantly lubricated with tears and thin mucus, permit the rolling movements of the eye to take place with the least possible friction. It is important to notice that in a healthy young person the portion of the conjunctiva lining the lids is of a delicate pink or reddish colour, whilst where it covers the white of the eye it is very pale, and only streaked here and there with a few large vessels, chiefly situated at the inner and outer angles of the eye. As age advances slight inflammatory troubles are not uncommon, and the portion of the membrane lining the lids assumes a fiery red appearance, whilst that which covers the globe of the eye loses its pearly hue, and becomes more or less streaked with distinct large or leashes of small vessels.

As this membrane is the most exposed to external injury, so is it the most frequently inflamed, and many of the minor troubles, as well as some of the more serious diseases of the eye which not unfrequently terminate in blindness, are due to inflammation of its structure.

The outer coat of the eye (A B) is a strong, dense membrane, and though continuous throughout, is divisible into two portions, of which the front part, or cornea (A), is transparent, whilst the back part, or sclerotic (B), is opaque. The cornea forms about one-fifth of the circumference of the globe, and the sclerotic forms the remaining four-fifths.

The sclerotic coat, which forms the white of the eye, is a strong dense cup, well fitted to enclose and protect the delicate structures in its interior. It is formed of a close web of fibres, with comparatively few and small blood-vessels, the absence of which accounts to some extent for its pearly aspect. Behind, it presents an opening for the passage of the optic nerve. In front, it is continuous with the cornea, and however different these two parts may appear to be in physical character, they nevertheless pass into each other by gradations that are almost imperceptible in sections examined with the microscope. The sclerotic fulfils several purposes. It gives to the eye its firmness and power of resisting pressure: a fact that is particularly well exemplified in the eye of the whale; for in the profound depths of the ocean to which this animal descends the pressure exerted upon the eye, as upon all the external parts of the body, is immense. The thick coating of fat by which the body generally is covered enables it, amongst other purposes, to resist this pressure with impunity, but the eye requires a special provision, and this is found in an enormous increase of the sclerotic, which at its posterior part attains in the whale a thickness of nearly half an inch. In addition, the sclerotic forms a solid crust, or shell, to the eye, into which the muscles by which the rolling movements are effected may be implanted. Lastly, its solidity and strength, as well as its uniform curvature, admirably adapt it to play the part of a mould or bed, on which, the highly-vascular choroid tunic alone intervening, the delicate retina may be laid down without danger of the formation of folds or plaits.

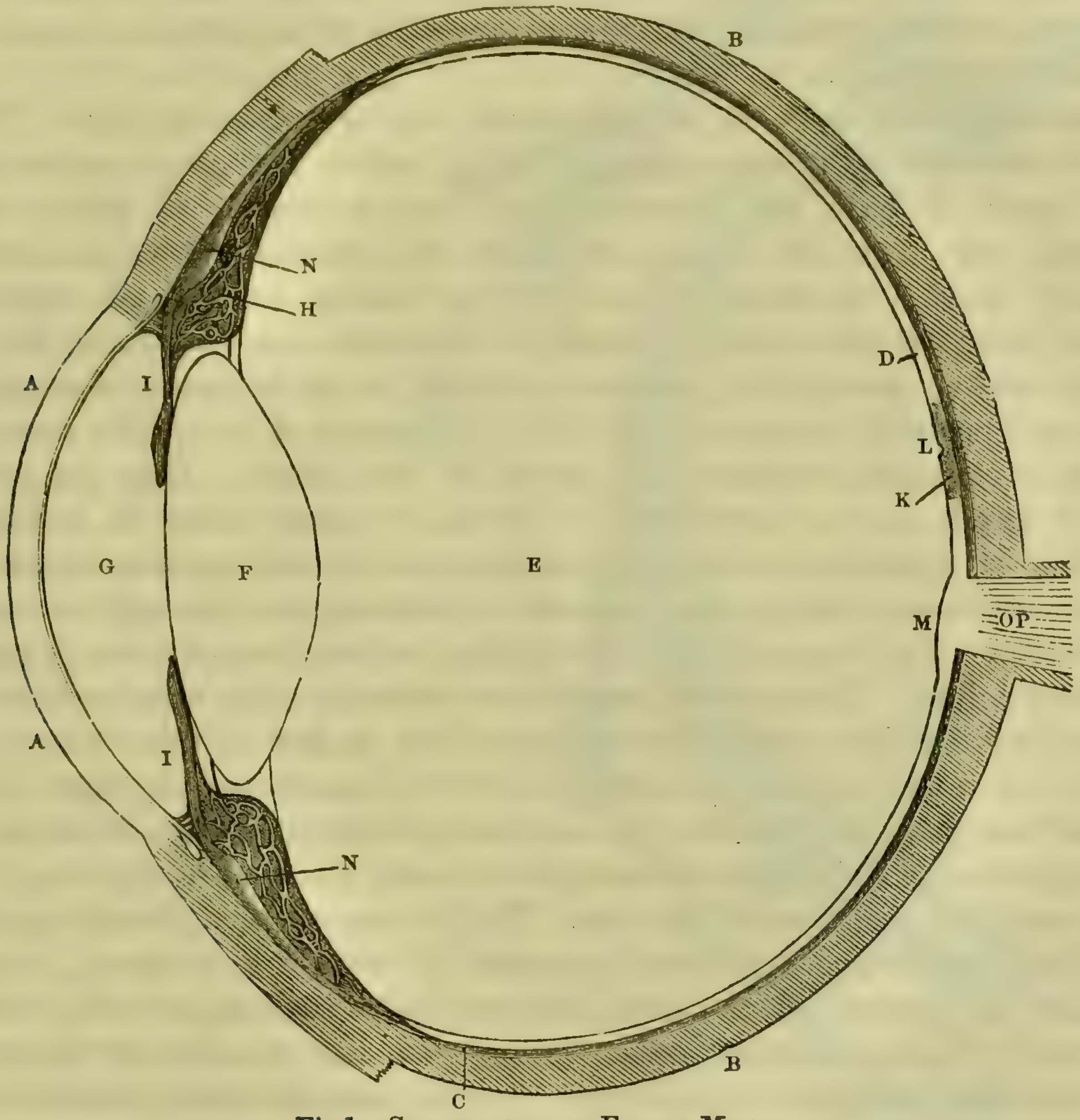


Fig 1.—Section of the Eye in Man.

A A, Cornea; B B, Sclerotic; C, Choroid; D, Retina; E, Vitreous Humour; F, Lens; G, Aqueous Humour; H, Ciliary Processes; I, Iris; K, Yellow Spot; L, Fovea Centralis; M, Optic Papilla; N, Ciliary Muscle; O P, Optic Nerve.

The *cornea*, or glass of the eye (A A), is the clear, transparent, exquisitely polished window through which light penetrates to the retina. In only too many instances it is owing to its opacity that, whilst all the parts lying behind it are healthy, sight is irrecoverably lost; and it is sad to think that no means have yet been discovered by which, when rendered opaque by inflammation, burns, or the action of chemical agents, it can again be cleared, though the resources of surgery, by displacing the pupil, can sometimes utilise in a remarkable manner the smallest segment that retains its transparency. Opacity of the cornea is a common result of small-pox, measles, or scarlet-fever, and especially of an affection known as the purulent eye of infancy.

Beautifully clear as it is, it still has a very complex structure. The outer surface is covered with many layers of cells, whilst the inner surface is lined by one layer of cells, and between these are a number of plates, arranged horizontally one over the other, of which the outermost and innermost are particularly elastic. In health it has no blood-vessels, since these would render it opaque, though it often becomes bloodshot in disease—an appearance that is due in part to minute pre-existing channels widening so as to permit blood-corpuscles to enter, and probably in part also to the development of altogether new vessels. The value of the cells in front of the cornea is very great. They are structures which, if spoilt, can be reproduced. Hence, in many cases of inflammation, though they are partially lost through ulceration, and vision is greatly impaired for a time, yet, as recovery takes place they are reproduced, and the sufferer can see as well as before. Their capacity for reproduction enables the eye to resist apparently very serious injury. Thus, several cases are on record in which lead-workers having poured molten lead into a cavity containing a drop or two of water have caused an explosion, the water becoming suddenly converted into steam. A splash of the hot metal has been propelled into the eye, and, owing to its liquid condition, has spread over its surface as a thin plate between the eye and the eyelids, forming, in fact, a perfect mould of the front of the eye. Yet, in some cases, though it might be inferred that the destruction of the eye would be certain and speedy, it has been found that on removal of the metal the eye has remained perfectly clear, or, at most, suffered from temporary inflammation, with loss of some of the superficial cells, which have been soon reproduced. In like manner, small particles of metal struck off with hammers, wings of small beetles, and many other minute and more or less pointed objects, are apt to become impacted in the cells of the cornea, but if removed by a light and skilful hand leave no permanent defect behind.

The next coat, or tunic, of the eye is the *choroid* (C, Fig. 1), (*c d*, Fig. 2), which distantly resembles a cup of black velvet, with the pile surface turned inwards. In velvet the pile consists of short fibres standing vertically on a base of coarser threads; but in the choroid the coarser threads are blood-vessels, some of which convey blood to the part, and are named arteries (*a c*, Fig. 2), whilst others convey it away and return it to the heart, and are named veins (*x*, Fig. 2). The pile of the choroid, instead of consisting of solid single fibres like that of velvet, is composed of myriads of loops of minute blood-vessels, or capillaries (*d d*, Fig. 2), which establish a connection between the arteries and veins, and in which a constant stream of blood is flowing to bring nourishment and oxygen to the retina and adjoining parts, and to carry away the materials which have been used up, and are no longer of service in the act of vision. Intermingled with the vessels are delicate fibres of supporting tissue, with a large number of pigment-cells, the office of which is to absorb those rays of light that do not actually form the image; their value is shown by the difficulty experienced by albinos, in whom they are absent, in seeing in the bright light of day.

The choroid has been described as a cup. Now, if we imagine the edges of the cup to be plaited, or pinched up into folds for a certain distance, and then becoming smooth again, to turn in till they almost meet in the centre, leaving only a small round hole, we shall obtain an idea of the mode in which the fore part of the choroid forms the ciliary processes (H, Fig. 1) and the iris (I, Fig. 1), with its central aperture, or pupil. The ciliary processes, which are about seventy in number, are arranged regularly around the eye, close to the margin of the cornea and sclerotic, and consist of masses of small blood-vessels, bringing the materials of nourishment into moderate proximity to the lens. The reason of their large numbers is not difficult to give. Most organs of the body are pervaded with blood-vessels, and nearly everywhere the elements of the tissues are thus brought into close relation with the blood; but in the case of the lens of the eye it is impossible that this arrangement can be adopted. Blood is an extremely opaque fluid, and a very thin layer of it is sufficient to exclude light;

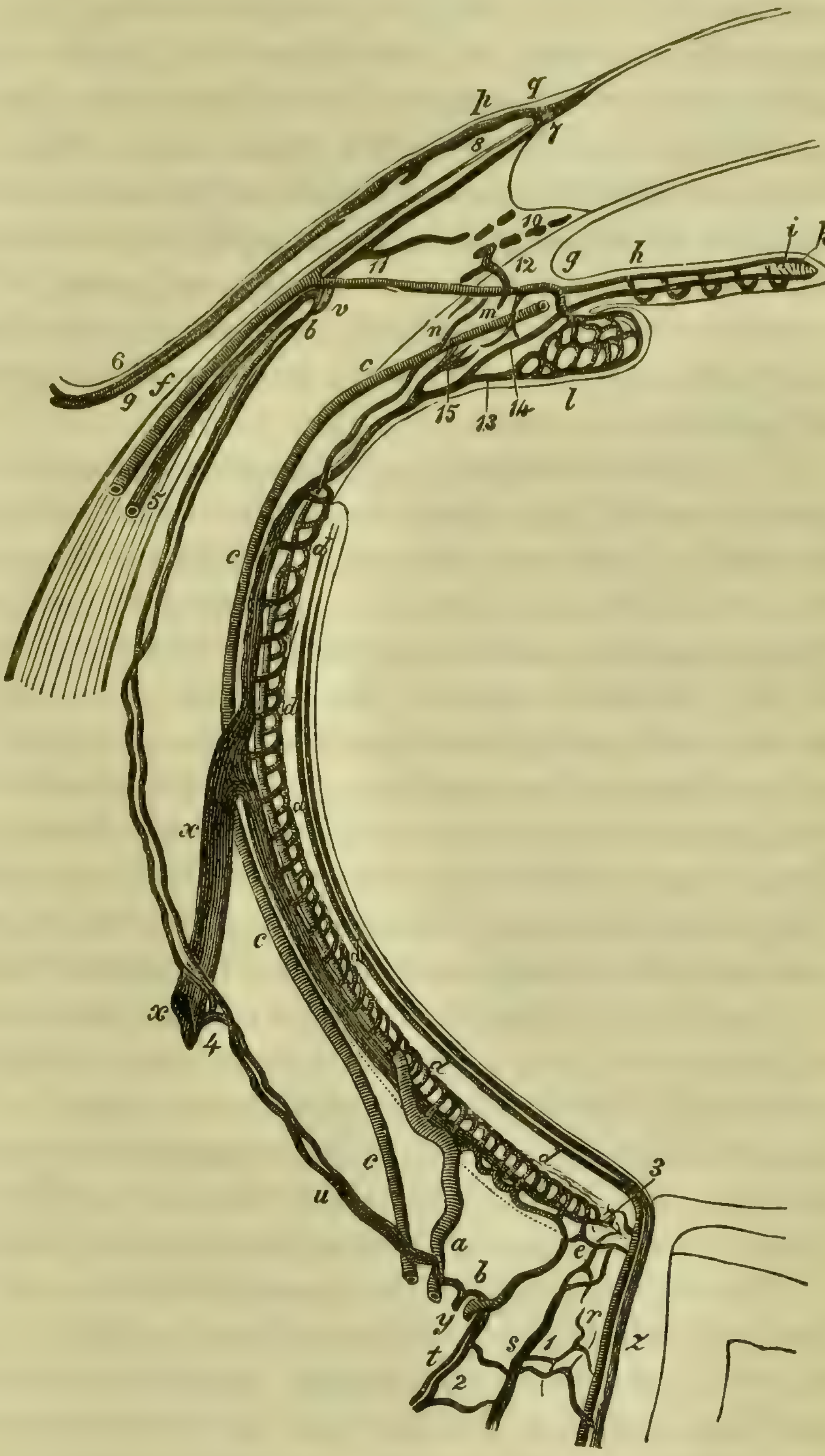


Fig. 2.—Diagram showing the Arrangements of the Blood-vessels of the Eye.

a, *b*, *c*, ciliary arteries; *d*, *d*, the fine loops of capillary vessels; *f*, one of the straight muscles; *g*, *h*, *i*, *k*, iris; *m*, *n*, small vessels communicating both with external and internal vessels of the eye; *p*, *q*, conjunctival vessels; *x*, one of the venæ vorticosæ; *u*, ciliary vein; *z*, central artery and vein of the retina; 1, 2, short ciliary artery and vein; 3, communication between central artery of retina and ciliary vessels; 4, vein conveying blood to vena vorticosa; 5, sub-conjunctival vessel; 6, episcleral vessel; 7, communication between conjunctival and muscular vessel; 8, 9, conjunctival vein; 10, canal of Schlemm; 11, communication between outer and inner vessels of eye; 12, position of canal of Fontana; 13, 14, 15, vessels of the ciliary processes.

but in the lens perfect transparency is required, and hence the blood-vessels, instead of being distributed over its surface and penetrating its substance, are massed together at its sides, and the nourishment they bring diffuses into the fluid which surrounds the lens, and maintains it in health. Such an arrangement, however, implies that the processes of nutrition in the lens are slow, and it is observable accordingly that the changes which take place in it in disease are gradual. Hence we find that senile cataract, or the cataract of old age, which is a failure of nutrition of the lens, advances generally with slow and hesitating steps, its development usually extending over several years. In addition to their office of nourishing the lens, the ciliary processes are also important agents in affording the supply of blood requisite for the secretion of the aqueous humour, to which reference will presently be made.

The front in-turned rim of the choroidal cup is the *iris*, which derives its name from its varied hue. Dark brown or black is the prevailing tint of the nations of the world, being seen amongst the Eskimo—those curious remnants of an ancient race—the Chinese, Americans, and almost all the people inhabiting India, Southern Europe, and the continent of Africa, whilst grey and blue irides are characteristic of the Teutonic races. The surface, if closely examined with a hand-glass, presents radii, which are interrupted near the pupil by a slight thickening; and at various times, when popular excitement has existed or when superstition has been rife, words or letters have, with a little aid from fancy, been read on the surface. Thus, about 1830 there was a girl in Paris who was said to have the words "Napoléon Empereur" inscribed upon her iris, but in whom the supposed letters were only the natural markings read by willing believers.

The two irides are not always of the same colour, one being blue, the other reddish-brown, or of a lighter or darker tint; and it is not uncommon to meet with persons who have reddish or dark brown spots on a blue iris, the spots sometimes being of large size, and occupying a considerable portion of the surface. In albinos the iris is of a reddish tint, due to the absence of pigment, and to the colour of the blood in the blood-vessels shining through their walls.

The pupil is a hole in the centre of the iris, and through this hole the only light that is admitted to the interior of the eye enters. It is perfectly circular, and when the iris is at rest has an average diameter of about one-sixth of an inch. Great variations, however, are met with in this respect in different persons, and in the same person at different times. Thus in some, especially in those who are of a sanguine temperament, the diameter of the pupil may not exceed one-eighth of an inch, or even less, whilst in those of sluggish habit it is sometimes as much as one-fourth of an inch. The iris, though chiefly composed of blood-vessels, possesses two sets of muscular fibres, one set being arranged concentrically to the pupil, the other radiating from the pupil towards the circumference. The variations in size which the pupil presents are dependent on the action of these muscular fibres: when the circular fibres contract, it is diminished; when the radiating fibres contract, it enlarges; and the action of these two sets of muscular fibres is chiefly brought into play by differences in the degrees of light. When the eye is exposed to bright light the circular fibres contract, and the pupil is reduced to the size of a hole made by a large pin, whilst in darkness it dilates to its utmost extent. The object of these changes is sufficiently apparent, for the entrance of a powerful beam of light into the eye harms the retina, confuses the images cast upon it, exhausts its powers, and impairs its perceptive faculty, rendering it for some time incapable of receiving other impressions. The pupil is, therefore, contracted to its narrowest dimensions, to allow as small a beam as possible to enter. On the other hand, when light is deficient it is important that all the rays falling upon the eye should be admitted, and hence the pupil enlarges. In man these variations in the size of the pupil are quite involuntary, and constitute typical examples of what are termed reflex acts with consciousness. The succession of events is that light falling on the retina constitutes a stimulus which produces a vibration that is conveyed to the brain by the optic nerve, where it awakens consciousness by exciting certain nerve cells; these are connected with others which possess the power of directing motor impulses to the circular muscular fibres of the iris. There is, therefore, a kind of reflection at the brain—a change of a sensory impression into a motor impulse, which has led to its being termed a reflex act. When consciousness is wholly lost, as in persons deeply under the influence of chloroform, the pupil is usually somewhat dilated, but does not become smaller when light is allowed to fall on the eye. In many animals, but especially in those that are of nocturnal habits, as the owl and the cat, the movements of the pupil are not altogether involuntary, but are partly dependent upon the will of the animal; so that if one of these nocturnal predacious animals be examined for a short time, it will be seen that the pupil enlarges and contracts quite independently of any variation in the amount of light that enters it; and it is probable that it is correlated with the requirements of the visual power when the animal is in pursuit of its prey.

But the size of the pupil is not, even in man, exclusively due to the amount of light that falls upon the retina; it depends in part on the accommodation of the eye for objects at varying distances. Thus, if a remote object be looked at, the pupil is of moderate or normal width; but if the eyes be now suddenly made to converge upon an object not more than a few inches distant from it, the pupil will be observed to contract. This appears to be due to the circumstance that its contraction corrects the spherical aberration of the lens: that is to say, that since those rays of light which traverse the outer or marginal part of the lens come to a focus sooner than those which pass through it near its centre, the contraction of the iris, and the consequent smaller size of the pupil, by cutting off the outermost rays of the cone of light falling upon the lens, and permitting only the central rays to traverse it, necessarily contributes to the formation of sharper and better-defined images upon the retina.

The size of the pupil, again, varies with mental emotions; and the large pupil which accompanies the emotion of fear is very characteristic of that condition of the mind. And yet, again, the size of the pupil is, to some extent, a telltale of the state of the bodily health and general vigour of system; for it may be observed to be large and languid in its movements in those who are depressed and exhausted by long illness or protracted watching, whilst it is smaller, and certainly contracts and dilates more actively, in those who are healthy and strong.

Lastly, the size of the pupil can be powerfully influenced by various poisons; the belladonna plant, for example, as well as many others belonging to the natural order *Solanaceæ*, contains an alkaloid named atropine, or some closely-allied compound, which, even when applied to the eyes in almost inappreciable quantities, possesses the remarkable power of effecting great dilatation of the pupil, which will remain immovable for hours; whilst eserine, an alkaloid obtained from the Australian tree named *Physostigma venenosum*, is capable of effecting its contraction to a very minute hole. The opposed action of these two substances, which are easily applied to the eye, and produce little or no pain, renders them invaluable agents to the ophthalmic surgeon in various conditions of disease. The average distance of the centres of the two pupils from each other is two inches and one-third.

The third coat, or tunic, of the eye is the retina (D, Fig. 1), which is the specially-modified termination of the optic nerve. It is an exquisitely delicate transparent layer, which lines the back part of the eye. It was long thought to be colourless, but researches made during the last few years have shown that in the living body it possesses a pink or rosy hue. The complexity of the retina is very great; and no less than ten strata have been shown to exist in it, the uses of some of which have not at present been ascertained, or even conjectured. The outermost stratum, or layer, consists of a series of rods arranged side by side, so that when seen upon the flat they present the aspect of a mosaic. Their uniformity is interrupted here and there by a larger, but shorter, body, called, from its shape, a cone; and it is remarkable that the cones are exclusively present at that part of the retina which is most sensitive, namely, the yellow spot (K, Fig. 1).

The smallest object that can be seen forms an image on the retina that is about the diameter of one of the cones. The other layers of the retina consist of specially modified nerve tissue; but it is unnecessary to enter into minute details in regard to them.

The tint of the retina is due to a red colouring matter, which can be obtained in a separate state, and has been named rhodopsin, or visual purple; and some interesting facts have been determined in respect to it. It exists chiefly in the outer part of the rods and cones; it is soluble in water and various other liquids, and is rapidly bleached when exposed to light. If the eye of an animal killed in a dark room, or in one illuminated only by monochromatic light, such as that of burning sodium, be quickly removed from the head and examined, it is found to be of a bright rose-red; but on admitting the light of day, it rapidly becomes paler, then changes to the hue of chamois leather, and finally assumes a dull grey tint. If it be now covered up from sunlight, and kept for some time in a dark chamber, a tinge of colour reappears; and it seems probable that the colouring matter is formed from material actually present in the rods and cones. This is, of course, soon used up after death; but during life we may suppose that it is constantly being renewed, and that as fast as exposure to light bleaches it new material for its restoration is brought by the blood circulating in the vessels of the retina.

It is impossible not to recognise the similarity that the eye, as a whole, presents to a photographic apparatus. The globe itself is the camera obscura, from which rays of light other than those passing through the lens, and destined to form the picture of the outer world, are carefully cut off by the pigment of the choroid and the opaque iris. The retina is the sensitised plate on which the picture is received, the lights bleaching it rapidly, whilst the shadows produce but slight change in it. In health, however, there is no fixing of the image and retaining it for future use. The picture, if retained at all, is written on the tablets of the brain, whence it can be recalled by an act of memory. But that the bleaching action above referred to really occurs has been demonstrated by placing the eye of a rabbit with widely-dilated pupil before a window. For, the animal being quickly killed, and the retina exposed under monochromatic light, the image has been fixed by plunging it into a little weak alum and water, and after the lapse even of a day or two, if preserved from light, the retina has exhibited the cross-bars of the window. This experiment gave rise to the absurd story current some years ago, to the effect that, in cases of murder, the assailant might be recognised by the image preserved on the retina of the victim. It will, however, be seen from the above account that it would be necessary that the light of day should be immediately excluded, and that special measures should be adopted to preserve the picture.

The humours of the eye are three in number, though one of them at least scarcely deserves that appellation—the aqueous, the lens, and the vitreous. The aqueous occupies the spaces marked 4 and 15, Fig. 3, and named the anterior and posterior chambers, which communicate with each other through the pupil. There are about ten drops of this watery fluid, and it is very clear and transparent. It contains a very small quantity of salts. It is probably produced by the ciliary processes, and is discharged into the posterior chamber of the eye, from which it passes into the anterior chamber, and then drains away through channels situated near the margin of the cornea.

The use of the aqueous humour is to maintain a uniform tension of the eye, so that no injurious pressure may be exerted upon the sensory nervous apparatus with the varying amounts of blood that enter or escape from the eye; and, in accordance with this, we find that a quick circulation takes place in it, blood or other colouring matter injected into the anterior chamber being rapidly washed away, whilst if it is allowed to escape, as by puncture of the cornea—a proceeding often adopted for the relief of tension in the treatment of ophthalmic diseases—it is quickly reproduced.

The second humour of the eye is the lens F, Fig. 1, often called the crystalline lens, from its brightness and transparency. When removed from the eye, it is a body of about one-third of an inch in diameter and one-fourth of an inch in thickness. It is perfectly circular, and occupies a depression in the fore part of the vitreous humour. The iris rests upon its front surface, and all rays of light entering the eye through the pupil must traverse it. It is enclosed in a kind of bag, or capsule, and is kept in in position by a membrane which is attached to its edge, or margin, named the suspensory ligament. The lens is highly elastic, and differs in consistence in different parts, its outer surface being thin and jelly-like, whilst the centre is harder, and of the consistence of cheese.

The use of the lens is to cause the rays of light emitted by any luminous body to be brought to a focus upon the retina, and its transparency, therefore, is essential to the performance of the work it has to do. The slightest cloud or haziness of its surface or substance impairs its function, and by impeding the entrance of light interferes with clear vision. It is then said to be cataractous. An opaque lens is a cataract; and it is obvious that no spectacles or other means will aid the vision of a person whose lens is perfectly opaque any more than a pair of opera-glasses will assist a person with good vision to see objects on the other side of a ground-glass screen. Remove the screen from the one, and the lens from the other, and the objects previously obscured will at once become visible, though in the latter case an appropriate glass, making up for the lens he has lost, will be required.

The third humour is the vitreous humour (E, Fig. 1), which constitutes the greater part of the eye, and is of gelatinous consistence. It may be regarded as a medium destined to support the lens, which fits into a hollow of its surface, and to maintain it at such a distance from the back of the eye as to permit the rays of light passing through it to form distinct images on the retina. It is but slightly liable to disease, but is often the seat of the deposit of small particles of pigment, which, without being dangerous, are troublesome, and indicate in most instances that the eye has been overtaxed.

THE FUNCTIONS OF THE EYE.

We have now completed our account of the anatomy of the eye, and may proceed to consider how it acts in the performance of its work; and the first question that arises is, How are the images of external objects formed upon the retina?

The mode in which an accurate image of distant external objects is formed upon the retina is not difficult to understand. It is only requisite to bear in mind that light travels in straight lines, and that the physical conditions of the humours of the eye are such that parallel rays falling upon the eye, and entering through the pupil, are brought to a focus upon the retina. Those rays that come from any object situated in the upper part of the field of vision are focussed on the lower part of the retina; those that are situated in the lower part of the field of vision are focussed on the upper part of the retina. Thus, an inverted image of every external object is formed on the retina, and an inverted image of precisely similar character can be obtained with the greatest ease on a sheet of white paper by simply holding an ordinary lens two or three inches away from it. The trees and sky will then be seen to be inverted, and the chimneys of the opposite houses will point downwards.

It has just been stated that the healthy eye when at rest is adapted for bringing parallel rays to a focus upon the retina. In point of fact, however, there are no such parallel rays in nature. Even those which emanate from the sun or from stars, the most distant objects with which we are acquainted, are only approximately parallel, and are, in reality, slightly divergent. But for all practical purposes of vision, rays which proceed from an object more than twenty *feet* distant may be regarded as parallel, and all such rays the normal eye can, without effort, bring to a focus on the retina. But rays of light emanating from objects a few *inches* from the eye are strongly divergent, and would not, therefore, if the eye remained unchanged, be brought to a focus upon, but behind, the retina, and a blurred and indistinct image would be the necessary consequence. To surmount this difficulty, the eye is endowed with a faculty of accommodation.

By the term accommodation of the eye is understood the power which the eye possesses of adapting itself to see objects at different distances distinctly. In sitting for a photographic portrait, the operator places the sitter at a variable distance from the instrument, and then arranges his glasses so that a sharp and well-defined image falls on the sensitive film of iodised silver. Nay, more; if the operator be an artist, he will place the hands of the sitter in a certain position, for he knows that if they be too far forward they will be out of focus, and that they will not only appear larger than natural, but ill-defined and blurred in outline: he knows, in fact, that the image of the face and of the hands will not be equally clearly defined unless they are nearly on the same plane, nearly at the same distance from the sensitised plate. He knows that he cannot obtain a good picture of fore, middle, and back ground simultaneously; to obtain absolute clearness and definition of either one of these three, the other two must be sacrificed to a greater or less extent. If he wishes to make the foreground distinct, he must draw the tube out a little and make it longer; if he wishes to emphasise the background and distant objects, then he must screw his instrument up a little and make the tube shorter. He must accommodate his instrument to the distance he wishes to make most distinct; and he is the best photographer by whom the imperfection of the instrument is distributed, so that images of objects in all places are tolerably clear, and none dim.

What the photographer does roughly and with his hands, the eye does for itself, by virtue of a power it possesses of increasing or diminishing the thickness of the lens contained in its interior; and this power is termed the faculty of accommodation. The possession of such a power by the eye can easily be made manifest. If a piece of tolerably fine net be placed at a distance of eight inches from the eye whilst standing opposite an open window commanding a prospect of moderate extent, it will be found that if the attention be directed to the threads of the net they can be readily seen and counted; but if the observer look at a man, a church, a tree, or any other object at some distance from him, the fibres and interstices of the net will become indistinct, and if he wishes again to count them he must make a certain amount of effort. The process by which the near or the distant object is rendered clear is said to be by a change in the accommodation of his eye. In looking at adistant object he relaxes his accommodation, in looking at a near object he exerts his accommodation. The question then arises, By what means is this accommodation effected?

The accompanying diagram (Fig. 3) will aid in understanding how accommodation is effected; and it will be seen that the figures 9, 10, 11, 12 point to a white striated band, formerly named the ciliary ligament, but which recent researches have shown to be a muscle. This muscle runs round the fore part of the eye, just beneath the junction of the cornea with the sclerotic, and at the outer border of the iris. Most of the fibres radiate as shown at 9—radiate outwards or backwards—but some, shown at 11 and 12, run in a circular direction. The muscle acts from a fixed point—its point of origin—marked 10, and when it contracts it pulls upon the choroid coat, 6, and brings this membrane forwards. The effect of this is to relax the suspensory ligament of the lens, 13. But the instant this is relaxed, the lens, being a highly elastic body, bulges forward, and instead of occupying the position which it does when the eye is at rest, shown on the right side of the drawing, it assumes that shown on the left. It becomes a thicker or a stronger lens, the amount of increased thickness depending on the degree of contraction of the ciliary muscle. The lens has thus become adapted for bringing more or less strongly divergent rays to a focus. If we look at a distant object, the muscle is not in action at all. The lens is compressed by the suspensory ligament, and it is adapted to bring the parallel or any very slightly diverging rays from the object we are regarding to a focus on the retina. If we look at an object ten feet distant, the muscle is brought moderately, and almost unconsciously, into play; it somewhat relaxes the suspensory ligament, and the lens becomes a little thicker, and therefore adapted to bring moderately diverging rays to a focus; if we bring the object to within three or four inches of the eye, the muscle is exerted to its utmost, the suspensory lens is completely relaxed, and the lens attains its greatest thickness. The shortest distance at which an object can be seen distinctly is named the "near point," and gradually recedes with advancing age. The elasticity of the lens and the activity of the ciliary muscle enables the child to have a great range of accommodation. He can see distant objects clearly, and he can also bring an object to within three inches of the eye, and still obtain sharp definition; but in middle age the near point has receded in the healthy eye to seven, eight, or more inches; an object

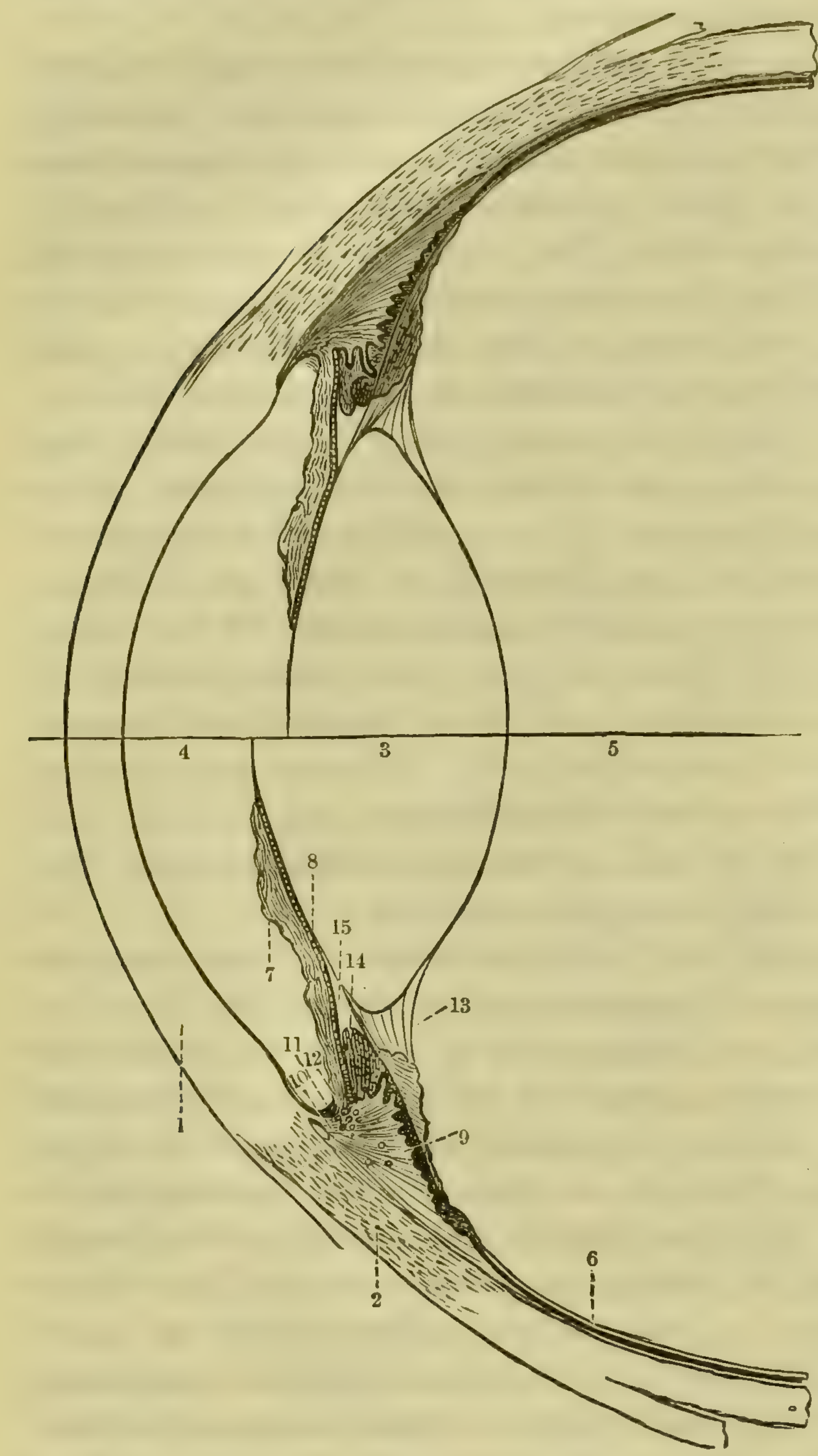


Fig. 3.—Diagram of the Front Half of the Eye, to show the Means by which Accommodation is effected.

1, Cornea; 2, Sclerotic; 3, Lens; 4, Aqueous Humour; 5, Vitreous; 6, Black Choroid lying on the sclerotic, and covered by the retina; 7, Iris; 8, Black layer of pigment behind the iris, named the Uvea; 9, Ciliary Muscle meridional fibres; 10, Origin of ciliary muscle; 11, 12, Circular fibres of ciliary muscle seen in section; 13, Suspensory ligament of the lens; 14, Tip of ciliary process; 15, Posterior chamber of the eye.

brought nearer than this may be distinctly perceived for a short time, but the effort soon occasions a feeling of fatigue and has to be discontinued. The old man, partly from failing power in his ciliary muscle, partly from diminished elasticity in his lens, has only a limited range of accommodation. He can still see distant objects well, but he can no longer bring the diverging rays emanating from near objects to a focus on his retina, and he holds his book, or the woman holds her work, at a great distance from the eye, to render the rays that come from these objects as nearly parallel as may be, and the condition of Presbyopia is then said to be established. But the removal of the object from the eye means the diminution of the size of the image on the retina, and so it comes to pass that if the book be held at such a distance that clear and well-defined images of the letters are formed on the retina, these are so small that they can no longer be perceived. Hence, the size of the print must be increased, or glasses must be used, which will bring the diverging rays emanating from near objects to a focus on the retina, and which thus supply the place of the failing or lost power of accommodation.

The act of accommodation is usually associated with convergence of the eyes, and it produces a certain amount of tension of the eye. If it be only exerted for a short time, no injurious influence is exercised upon the eye; but if prolonged, and especially during the early years of life, when the sclerotic is soft and yielding, it is apt to produce elongation of the globe, and thus to occasion Myopia.

The sharpness of vision differs considerably in different persons, and may certainly be greatly improved by habits of attention; but that it has not undergone material change for at least 4000 years is sufficiently attested by the fact that amongst the Arabs, whose pastoral habits, combined with the dryness and clearness of the atmosphere of their vast plains, led them to study the heavens at night, the small star Alcor was regarded as a test of good vision. They named it Saidak, or the "Tester." It is situated in the tail of the Great Bear, at a distance of 11′ 48″, or about one-fifth of a degree, from Mizar. It is about equal in brightness to a star of the fifth magnitude, but is to some extent overpowered by the brightness of Mizar. It is still just within the limits of ordinary healthy vision.

The satellites of Jupiter, on the other hand, may be regarded as just beyond the power of the ordinary eye to recognise; yet Humboldt informs us that a master tailor in Berlin, named Schön, was able to determine correctly with his unaided eye, on clear moonless nights, the precise position of these satellites. He saw the third satellite best; he could also distinguish the first when at the greatest distance from Jupiter; but he was unable to see the second (which is the smallest) or the fourth. The distances of the several satellites from Jupiter are 1′ 51″, 2′ 57″, 4′ 42″, and 8′ 16″. The third, which is the largest, is yellowish, and is equal in brightness to a star of the sixth or seventh magnitude. To most people the stars appear as bright objects, with long bright lines, or streamers, radiating from them; but Schön saw them as points of light, showing that the dioptric apparatus of his eye was adapted to bring parallel rays of light exactly to a focus on his retina.

It is probable that all those races of mankind who live on extensive plains, or who dwell on the sea, possess very piercing vision. Humboldt has placed on record the remarkable acuteness of vision possessed by the Peruvians. He states that he was much impressed by a circumstance which occurred during his stay at a beautiful country-seat of the Marquis de Salvalegre near Quito, from which the long ridge of the volcano of Pichincha was visible at a distance of 90,000 English feet, or about eighteen miles. His fellow-traveller, Bonpland, who was then engaged alone on an expedition to the volcano, was recognised by the Indians standing near "as a white point moving along the face of a black basaltic precipice," before Humboldt, who was looking for him with a telescope, could discover him. In a short time, however, having ascertained his position by this means, both Humboldt and his companion were able to discover the white moving figure with the naked eye. Bonpland was wrapped in a white cotton mantle, the poncho of the country. Allowing from three to five feet for the breadth of the shoulders, as the mantle sometimes clung close and sometimes seemed to fly loosely in the wind, and taking the known distance, we have from 7″ to 12″ as the angle under which the moving object was distinctly seen. White objects on a black ground, there can be no doubt, are visible at a greater distance than black objects on a white ground—a circumstance that is in part due to the phenomenon of irradiation.

Very recently it has been shown by Reich that the Georgians have exceptionally good vision for distant objects. Thus, in a company of Georgian infantry composed of 140 men, the vision was superior to the average in 83 per cent.; and there were no less than 32 per cent. whose vision was twice as good as the average European. They were almost all excellent shots, and their eyes were in all instances very dark. None of these men had been to school, and there was not a single myopic person amongst them; though it is known that in the State schools at Tiflis there are many myopes.

Again, the Nubians, eleven in number, who accompanied Reich's caravan in Breslau were carefully examined by Cohn. They were all young men and women, with one exception, and none of them could read or write, with the exception of this one, who was myopic, and who had worked at Arabic and read much. The sharpness of vision was in all the rest nearly double that of the average European, and in one case two and a half times better.

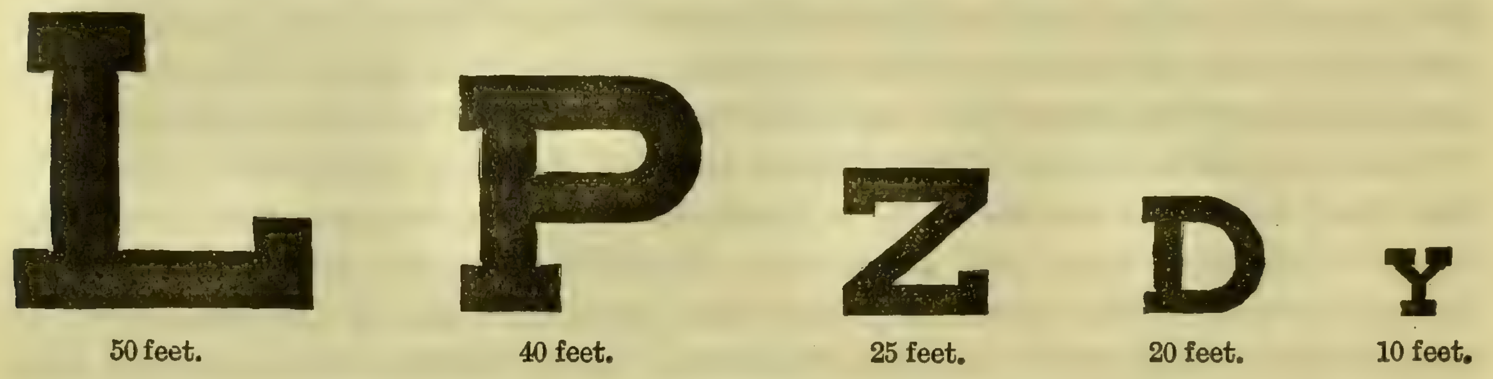
The limits of the field of vision were estimated as long ago as by Ptolemy, in the second century of our era; for Arago states that, according to Heliodorus of Larissa, Ptolemy announced that he had ascertained by experiment that the space which is visible, the eye remaining immovable, was limited by a rectangular cone: that is to say, by a cone having its apex at the pupil, and with the boundaries of the opposite sides parallel. Hence, in order that the horizon and the zenith should be seen simultaneously, the visual axis must, according to him, be elevated to a height of 45°; whilst if the eye be kept motionless we can never see more than one-fourth of the surface of the sky.

The superior instruments and more precise observation of the present day have enabled the field of vision to be accurately determined; and it is found, as might have been expected, that its extent and form vary slightly with the shape of the soft parts, and especially with the configuration of the nose, which, when prominent, limits the field of vision considerably on its inner side; but it also depends in part upon the fact that the sensitiveness of the retina is greater on the inner than on the outer side : and it is upon the inner side, of course, that the rays proceeding from objects situated at the outer part of the field of vision fall.

The mode in which the field of vision is obtained is by the employment of a semi-circular arc of iron which is capable of being rotated into a horizontal, vertical, or any intermediate position. To the semi-circle of iron a traveller bearing a disc of white paper is attached, so that the disc may be brought from the extremity of the arc to its centre. The person to be examined is placed with his back to the light, and directed to look steadily at a small button in the centre of the arc, the two arms of which arch from side to side of his head. The disc is now slowly brought round from a point where it is invisible to him to a point where it is visible, and the number of degrees of this point from the centre is noted. The same proceeding is practised from the opposite side, and the number again noted. The arc is now rotated to the vertical position, one arm stretching over the head, the other under the chin, and the disc again brought forward, and the degree noted. By repeating this proceeding with a series of intermediate positions, a kind of map or plan can be obtained, which shows that our field of vision extends from side to side, the eye remaining immovable, about 140°, and that from above downwards it extends over 120°.

A considerable portion of the field of vision of one eye is, however, covered by the other, so that the area in view, when the two eyes are open simultaneously, is not much more than 180° in extent. By rolling the eyes outwards, the head remaining immovable, some 80° more may be added ; and if the head itself be rotated, the whole circle may be completed. It is rather curious to find that, although the eyes of short-sighted persons are often large and prominent, their field of vision is considerably less than in long-sighted persons, in whom the eyes are usually smaller and less prominent.

Strictly speaking, we only appreciate degrees of light and colour with the eye ; and although it is generally considered that with our eyes, and our eyes alone, we can, in addition, distinguish size, form, motion, and relative position of objects, this is only in a certain sense true, for a rigorous examination of the mode in which our conceptions of size and form and motion are formed demonstrates that the impressions made upon the retina are materially aided by those of other senses, and especially by those of touch. The blind man to whom sight is given by the removal of a cataract that has existed from birth sees the outer world as a flat picture, in which there is no relief of parts, and he finds that practice and experience are necessary to fuse together the impressions of the eye with those of touch. He is unable, for example, to distinguish whether an object is one foot or many feet distant from him—whether an object is a sphere or only a disc. In order to learn that the table is nearer to him than the wall, he must learn that a muscular effort has to be made, a certain space to be traversed to reach the one which is not requisite for the other. To learn that an orange is round, he must grasp it, and complete by touch and muscular action the conception of a sphere. It is only by experience that the double and different images of the stereoscope are fused into one, and give the impression of solidity. But abstruse reasonings of this kind apart, it will be interesting to know what, in the adult man as ordinarily educated, the eye is capable of accomplishing, and what is to be regarded as healthy or average vision. The requirements in respect to vision are yearly becoming more exacting in the Services. The Army, and apparently also the Navy Boards, decline to fix any precise limit, on the ground that the condition of the vision is only one of the physical qualifications on which they determine the admission or rejection of candidates, and that it must be taken as a part of the whole. The limits of healthy vision will be here given; but it would be prudent for the parents or guardians of a boy commencing to work for the examinations required for the Public Services to have the eyes properly examined and tested. The defect may be slight, but the examinations for these services are now becoming very severe, requiring prolonged hours of study and hard work, and if the eyes should possess any defect of organisation, great injury may be done to them by nocturnal work, whilst the labour and anticipations of several years may be overthrown by sudden impairment of vision, due to over-exertion of an organ originally weak. Speaking roughly, the accompanying letters should be read at the distance in feet expressed by the numbers beneath them. Thus, the L should be distinguished at a distance of fifty feet, the P at a distance of forty feet, the Z at a distance of twenty-five feet, the D at a distance of twenty feet, and the Y at a distance of ten feet. Any person who is unable to read those letters at the distance named is suffering from some defect of vision; it may be short-sightedness, it may be haziness or cloudiness of the transparent media of the eye, or it may be some affection of the retina or brain, but whatsoever may be the cause, his vision is inferior to the average of mankind. Test letters of this kind, of a definite size, are very convenient to use, because they enable a comparison to be drawn between different persons having impaired vision, and constitute a means also by which, when vision is known to be imperfect from the presence of disease, its progress towards recovery or its deterioration may be noted from day to day. It is only necessary in such cases to throw the distance at which each letter is read and the distance at which it ought to be read into the form of a fraction, and the means of comparison is at once before us. Thus, supposing a person can only read the L at forty feet when he ought to read it at fifty, his vision can be expressed by the fraction of $\frac{40}{50}$; if he can only read it at ten feet, his vision is $\frac{10}{50}$; in other words, it may be said that his vision is reduced to $\frac{4}{5}$ or to $\frac{1}{5}$ of its normal acuteness.



In many instances the degree of impairment of vision is equal for each letter, so that in the event of L being only distinguishable at half its proper distance, or twenty-five feet, D can can only be read at half its proper distance, or ten feet; but this is by no means constant, and it is common to meet with persons who, whilst they are quite unable to distinguish the L at twenty-five, or even at twenty feet, can still read the Y at five feet. It by no means follows, moreover, that because the letters can be read at the distance named, or even at a greater distance, that the eye is perfectly natural, and capable of any amount of work upon near objects. It may be long-sighted, and whilst well adapted for seeing remote objects, yet be incapable of maintaining the effort which is required for work at close quarters upon minute objects. Careful measurements have been made to determine the size of the smallest object that can be perceived by an eye possessing average sharpness of vision, and it has been found to vary from $\frac{22}{10000}$ths of a millimeter to $\frac{68}{10000}$ths; but the size of one of the cones of the retina is about the same as the smallest of these two measurements, and hence it is concluded that if two objects were so small that when placed together their united area would not exceed $\frac{22}{10000}$ths of a a millimeter—that is to say, would only stimulate one cone—they would be seen as a single object. Expressing the fact in another way, it has been found that to be visible an object must subtend an angle of about thirty seconds. Lines, however, which strike many retinal elements consecutively are much more readily seen than points. A telegraph wire or a spider's web can be distinguished at a much greater distance than it would be possible to recognise a segment of it equal in length to its diameter. The above remarks apply only to small objects, under ordinary daylight illumination, but a sparkling object, such as a piece of gold-leaf, of much smaller size may be seen. Aubert found that he was only able to distinguish double stars when the interval between them amounted to as much as 3′ 30″.

Our appreciation of the size of an object depends partly on the actual number of the percipient elements of the retina that are stimulated by the luminous rays proceeding from the object, and partly on the effort that is made to converge the eyes upon it. The larger the surface of the retina that is covered by the image, the larger the visual angle under which it is seen, the greater is our estimate of the size of the body. But, on the other hand, the more we accommodate the eye for near vision, the smaller is our estimate of the size of the object regarded. As a rule, white objects on a black ground are seen at a greater distance than black on white, which is due to the phenomenon termed irradiation; for the white ground spreads or widens out, and hence tends to cover the edges of a black square or circle, whilst a white circle advances in all directions on the surrounding black ground. It is a mental, not a physical condition.

The duration of a stimulus capable of exciting the retina need only be very short, as is demonstrated by the visibility of an electric spark, which lasts only a minute fraction of a second; but the visual sense is much less capable than the sense of touch, or even of hearing, of recognising a succession of impulses or stimuli as separate and distinct impressions. In other words, there is a much greater disposition to fuse rapidly-succeeding impressions with the eye than with the other senses; or it might be yet again differently expressed, that impressions made on the eye last longer than in the case of the other senses. Thus, the more sensitive parts of the body, as the lips and tongue, can distinguish as interrupted the impulses of a tuning-fork vibrating 1,000 times in a second, and the ear can distinguish interruptions recurring 100 times in a second. But the eye retains the impression of a light for a second or more; hence the appearance of a circle of fire when a glowing ember is whirled round even by the hand. If coloured light is presented to the eye, and the eye is then suddenly closed, there is a short period during which the same colour is seen, termed the positive after-image; but this is soon replaced by a negative after-image, in which the image is seen of the opposite or complementary colour.

It is remarkable that in the oldest literary monuments of the world the sensations of colour should be only seldom and lightly referred to. Mr. Gladstone has pointed out, for example, that very few colours are mentioned by Homer, and of these few nearly all are misapplied. Geiger, again, states that neither in the Vedas of the Hindoos nor in the Zendavesta of the Parsees has he been able to find indications of a fully-developed sense of colour, no mention being made of blue, though the sky and light generally are specially described. Similarly, no mention of green occurs in the Rigveda Hymns, nor in the Zendavesta, though both often speak of the earth and its vegetation. Magnus, a recent writer on colour-sense, has arrived at the conclusion that mankind at first saw only white and black, that red was the first colour to be distinguished, and then the other colours in succession towards the violet end of the spectrum. He thinks that red and black and white were alone recognised at the time the Vedas were written, and that yellow was perceived in the Homeric period, green, blue, and violet being subsequently discriminated. He suggests that the colour-sense is still imperfect, and that the time may come when the ultra-violet rays will be distinguished by the human eye. Dr. Montague Lubbock holds a different opinion, and points to the ruins of Mycenæ, Assyria, and Egypt as affording evidence that man possessed a fairly-developed colour-sense at a very remote period. There seems reason for believing that the colour-sense can be improved by practice, for it has been noted that the number of colour-blind women is much less than that of colour-blind men, which is probably attributable to the attention women pay to dress. The proportion of colour-blind people varies in different nations, but is usually about 3 to 5 per cent.

All parts of the retina are not equally sensitive to colour, and this has been ascertained in the same way as the extent of the field of vision has been determined—namely, by slowly bringing coloured objects from behind the head, or other part where they cannot be seen, till they can be seen, and their colour can be correctly named. It is found that the presence of a blue, yellow, green, or scarlet object can be recognised for some time as an object before its colour can be correctly appreciated. The sensitiveness of the retina in those parts that are most distant from the entrance of the optic nerve, and upon which rays of light strike very obliquely through the pupil, is, however, lowered only, not abolished; for if some saturated colour—such, for example, as the blue or green of the solar spectrum—be concentrated on the eye, the colour can be perceived to the utmost limits of the retina; but if a piece of coloured paper of the size of a shilling, or a fragment of coloured worsted—the vividness of the colour of which is so much less than that of the spectral colours—be brought into the field of vision in the manner indicated, it will be found that blue can first be recognised, then red, then green: that is to say, it is only the more central part of the field of vision that is capable of distinguishing green, whilst nearly the whole of the retina can distinguish white or blue, the part that can recognise red occupying an area of intermediate size. The field of vision for each colour differs a little in the different meridians of the eye, the area for green being an oval placed horizontally, whilst the areas for red and blue are more nearly circular in outline. In some forms of disease affecting the nervous system of the eye the appreciation of colours is remarkably modified or impaired, and the affection sometimes called Daltonism, from the distinguished philosopher who suffered from it and described it, is due to inability to distinguish one or more of the colours. Red-blindness, from which Dalton suffered, is the most common ; then green-blindness. The loss or absence of the power of appreciating blue is rare. The importance of the possession of an accurate knowledge of colour by all those engaged in operations conducted by means of coloured signals is now becoming generally recognised; and as there is reason to fear that many fatal accidents, both by land and sea, have been occasioned by inability on the part of engine-drivers, guards, and helmsmen to distinguish green from red, it is now the practice to submit the men applying for such posts to tests for colour-blindness—a proceeding that will certainly prove of advantage to the public.

THE EFFECTS OF VARIATIONS OF LIGHT AND TEMPERATURE.

Having described the structure and functions of the eye, so far as it is necessary to enable the following observations to be understood, we may with advantage consider the action of great variations of light and of temperature to which all are liable, and which in conditions of disease undoubtedly exert a powerful influence.

It may be safely stated that some disease of the eyes or disorder of the general health is present if the ordinary and diffused light of day, and still more, if candle or lamp-light, is felt to be painful. Artificial light of every kind—candles, oil-lamps, gas, and even the electric light itself—is very feeble compared with sun-light; and yet sun-light is that form of light to which all living beings have been exposed from their first appearance on the earth, and to which, therefore, we must suppose that their eyes have, in the course of many generations, become structurally adapted.

Every one must have noticed the low penetrating powers of even the most powerful electric light in hazy conditions of the atmosphere, as compared with the sun. It has been estimated that the light emitted by the sun and falling on a page of such a book as this is about 60,000 times greater than that of a good wax candle placed at a distance of one yard from it, and about as much greater than the light of the moon at the full.

But if the diffused light of day is well borne by every healthy eye, there can be no doubt that the direct light of the sun is injurious if allowed to fall upon the eye. The case of Sir Isaac Newton is well known. Impelled by curiosity, he ventured to look at the sun directly through a telescope; the effects were both serious and permanent. He was obliged to keep in a dark room for a considerable period, and the image of the sun had so far impressed itself upon his retina—burnt itself in, as it were—that years afterwards, when he had ceased to notice the spots, it was only requisite that he should direct his attention to the subject to cause him to see the spectra of the sun which had formerly distressed him. In this case, however the light of the sun was concentrated by lenses, and the retina was therefore acted upon as by a burning-glass.

Still, the bad effects of long exposure to the bright rays of the sun, and especially of its reflection from the sands of the desert, from snow, from the sea, from arid plains and rocks of bright colour, are noticed by all travellers, and numerous expedients have been adopted to save the eyes. In a great part of India the sun is scorching for three months of the year. The thermometer often rises above 100° in the shade during part of the hottest days : it has been known to reach 120° Fahr. ; even the wind is hot, the land is brown and parched, dust flies in whirlwinds, all brooks become dry, small rivers scarcely keep up a stream, and the largest are reduced to comparatively narrow channels in the midst of vast sandy beds. Is it surprising that a part of the body so delicately constructed as the eye should feel such a degree of heat, attended with such intense radiation of light and dryness? And, indeed, those who have had large experience of the ophthalmic diseases of this and other hot climates state that headaches are not uncommon from exposure to the direct rays of the sun, and that the end of the optic nerve may in such cases be observed to be reddened, and in an incipient condition of inflammation. Still, either the natives of India and other parts of the torrid zone must be extraordinarily careful in regard to such exposure, or the effects of bright light must have been somewhat exaggerated, since cases of inflammation of the retina do not appear to be much more frequent there than elsewhere. It is probable that the large amount of pigment which their eyes contain absorbs the light, and prevents to a certain extent those injurious consequences that would otherwise result.

Denham and Clapperton, in their travels through the country of Bornou, just south of the Great Sahara, where the intensity of the light during the day is very great, found that blindness was a prevalent disease. Within the walls of the chief city there was a separate district, or village, for people afflicted with this infirmity, who had certain allowances from the governor, but who also begged in the streets and market-place. With the exception of the slaves, none but the blind were permitted to live here, unless on rare occasions a one-eyed man was received into their community.

There are certain effects of over-stimulation and exhaustion of the retina by the bright glare of white light which are well known to result from long exposure to snow. Dr. H. Cayley gives in the *Indian Medical Gazette* for 1868 an interesting account of his experience of snow-blindness in crossing the "Zoji La" Pass from Cashmir to Ladak. He states that on the day of crossing the pass his party were on the move for more than sixteen hours over fresh-fallen snow the whole way, and soon after midday he noticed some of the baggage servants and coolies stumbling along with their eyes covered, and protected as much as possible, and all complaining of intense burning and throbbing in the eyeballs, of headache, and of dimness of sight. Dr. Cayley recommended what he had heard was serviceable from natives, and had himself found to give great relief : viz., the application of a handful of snow on the eyes for a few minutes till the burning was removed, and the repetition of this proceeding at intervals. After the march was over and during the night, all those whose eyes were affected, consisting of nearly half the party, suffered most acutely from deep-seated pain in the eyes and orbits, with more or less complete loss of sight, and many of the coolies, who were all hill men, and accustomed to the snow, were sitting out in the cold night air, groaning with pain, but finding their sufferings less than in the smoky huts. The next morning two of the servants and about twenty-five coolies were suffering in a greater or less degree from the following symptoms: almost complete loss of sight—they could just see their way about, but some even were quite blind—the most intense intolerance of light, severe deep-seated pain and burning in the eyeballs and orbits, and generally bad headache. The other symptoms were profuse lacrymation, injection of the conjunctiva, and swelling and puffiness of the lids, and contracted and inactive pupils —acute ophthalmia, in fact, with the symptom of nervous irritation especially prominent. In some only one eye was affected, but generally both, though not always in the same degree. In some the affection commenced after the day's march and exposure were over, but this occurred chiefly amongst those who went into the huts, and who were consequently exposed to the irritating vapours arising from fires made of wood and animal dung. The treatment employed by Dr. Cayley, and which he states gave great relief, consisted of warm fomentations, and a lotion of equal parts of tincture of opium and water dropped into the eyes, and keeping the eyes covered with a wet bandage.

Nordenskiöld, in his account of the voyage of the *Vega*, remarks that the eyes of the Chuckches suffer terribly during the spring from the strong light of the sun upon the snow. Many wear a green shade in the shape of the peak of a cap. It is noticeable, however, that notwithstanding this frequently-repeated periodic strain upon their eyes, they have, as a rule, exceedingly good vision.

The Tartars are said to protect their eyes when travelling in winter from the injurious effects of snow by means of a contrivance made of horse-hair, similar to crape spectacles: and the Eskimos, who are familiar with the injurious effects of snow, use guards composed of wood, with slits in them, through which a comparatively small quantity of light only can penetrate to the eye.

Gauze wire spectacles were suggested by Curtis, and have been commonly used.

A remarkable condition, known as night-blindness, often results from retinal exhaustion, due to protracted exposure to bright light; and many interesting cases have been placed on record. Amongst others, the following may be mentioned:—

Captain Smith, R.N., of H.M.S. *Merlin*, reports in the "Royal Naval Biography" (Vol. IV.) that in September, 1801, the *Merlin* captured a Spanish privateer, and having been sent with twenty men to cruise in her as a tender, he states that in a few days at least half the crew were affected with night-blindness. They were chased one calm morning by a large Xebec, carrying from eighty to one hundred men, and towards evening she was fast pulling up to them, his people having been fagging at their oars many hours without any relief. Knowing that night would deprive half of his crew of sight, it was proposed to try conclusions with the enemy whilst it was daylight: a proposition that was answered by three cheers. The oars were run across, and the enemy being by this time within gunshot, the action commenced. After a time, to their great relief, the Xebec sheered off and pulled away from them. They in their turn became the pursuers; but when night came on they took special care to lay their head from the Xebec, and saw no more of her. This circumstance led Captain Smith to devise some means of curing the people affected with night-blindness, and he could think of none better than that of excluding the rays of the sun from one eye during the day by placing a handkerchief over it, and he was pleased to find on the succeeding night that it completely answered the desired purpose, and that the patients could see perfectly well with the eye which had been covered during the day, so that in future each person so affected had one eye for day and the other for night. It was amusing enough, he remarks, to see Jack guarding with tender care his night eye from any exposure, however slight, to the sun's rays, and occasionally changing the bandage, that each eye in turn might take a spell of night duty, it being found that guarding the eye from the action of light for one day was sufficient to restore the tone of the optic nerve.

Captain Smith concludes his interesting observations by remarking that this disease frequently attends scurvy in tropical climates, and is sometimes occasioned by derangement of the digestive organs and hepatic system.

This account fully agrees with what is now known in regard to the action of light upon the retina, to which reference has already been made. Men badly fed and exhausted by fatigue are not in a condition to reproduce the colouring matter of the retina, the small stock of which actually generated is soon exhausted by brilliant light, but the protection of the eye from light gives time for its renewal in sufficient quantity to fulfil its functions. The treatment adopted by Captain Smith, though, of course, he was unacquainted with its *rationale*, was extremely sensible, and as the event proved, thoroughly effective.

THE CARE OF THE EYE IN INFANCY.

The infant is liable to few diseases of the eyes, but those from which it does suffer are dangerous, and often fatal to vision. One of the most common of them, as well as one of the most serious, if neglected, is the affection known as purulent ophthalmia, or the purulent eye of new-born children. It usually makes its appearance on the third day after birth, and is attributable either to the entrance of some virus into the eye during birth or to some injudicious treatment by the nurse shortly after birth. Thus, it is a common practice with nurses to wash the new-born child with gin, and the entrance of a drop of this fluid into the eye would certainly set up acute inflammation. Exposure to cold draughts of air would be followed by the same result. But it is not with the mode of causation of the disease that we have here to deal; nor is it the object of this work to discuss the treatment of disease, which should be committed to the hands of those who are competent to undertake it, but purulent ophthalmia is one of those affections which a mother or nurse may be unexpectedly called upon to tend, and it may not be unwise to give a short account of the disease, and of the remedies that should be employed to prevent the destruction of the eye. This will seem the more necessary when it is stated that a very large proportion of the inmates of blind asylums owe their loss of sight to this particular form of inflammation, and when it is added that the treatment is simple, easily practised, and, as a rule, very successful. The symptoms, then, that are presented by the disease are that about the end of the second or the beginning of the third day after birth the nurse or mother observes a small accumulation of yellow matter at the inner corner of the eyes. The lids look a little puffy, and stick together when the infant wakes. The pain is trifling, for the child lies placid, and though it may show some signs of aversion to bright light, it sleeps and takes its food without difficulty. In the course of the next and following days, the yellow discharge increases in quantity, and drying up causes the lids to adhere during sleep; it then accumulates behind them, making them bulge considerably, and when they are opened, large yellow drops flow down the cheeks. It is difficult to see the eye at this period, but if the matter be cleared away, it appears somewhat red and inflamed, though less so than might be expected. The discharge reaches its maximum about the end of the second week, and after that period begins to decline, but too often only after irreparable mischief has been inflicted on the eye. It is during the second and third weeks that the greatest harm is wrought. Cases properly treated during the first week recover, in many instances, without mark of any kind. If, however, a case is neglected, and the discharge is profuse during the second week, irreparable damage is done to the cornea, which becomes hazy and ulcerated; but recovery may still take place, occasionally perfect, but more frequently with some opacity of the cornea, which may or may not permanently interfere with vision. If the case be still neglected, the third week witnesses the penetration of the cornea by the ulcer, or even the entire destruction of that membrane, allowing the escape of the humours, and the total collapse and loss of the eye. The progress of the disease is sometimes slower, the discharge being less abundant, and the child improves a little one day and becomes worse the next, such alternations extending over three or four weeks. In these cases, the chance of complete loss of the eye is much diminished. In some instances, again, the affection runs a violent and rapid course, unchecked by any remedies, and quickly destroys the eye. In these cases, the best directed and most skilfully applied treatment sometimes fails to save the eye, though it may leave it in a condition permitting relief from surgical treatment.

The interesting point in regard to purulent ophthalmia, from our present point of view, is that in a large proportion of cases it is a curable disease, and though the means employed are simple, yet they require to be practised with care and assiduity, and for a considerable period. The disease is an inflammation, the discharge chiefly comes from the surface of the lids, and if allowed to accumulate, probably becomes by its decomposition a source of irritation. The local treatment must be, then, as a mere matter of common sense, to clear away the discharge as much as possible, and to prevent its accumulation between the lids. If, in addition, there is any circumstance causing the general health of the infant to be disturbed, appropriate general treatment should be adopted.

How are these measures to be carried out? The nurse should be supplied with a glass syringe, capable of holding about two ounces of water, and at intervals of about three hours, and always before the child sleeps and after it wakes, the eyes should be syringed out. The water should be at a temperature of about 65° Fahr., or cool without being cold to the fingers. The same water should *not* be used twice. It is well, therefore, to have two basins, and the infant should be held with the head somewhat depending; and if it happen that one eye only is affected, which now and then occurs, this eye should be held lowermost, whilst a little pad of cotton-wool may be placed over the second eye, to prevent the entrance of any of the matter washed out by the syringe. The strength of the stream should be moderate; it should first play on the closed lids, then on the edges of the lids, so as to soften any dried secretion and cause no pain when they are opened, and finally, should be directed fairly on the surface of the eye itself. The syringing should be continued till all the yellow matter is washed away, which may generally be accomplished with four or five syringefuls of pure water. The head of the infant should be held firmly, and the nozzle of the syringe held at four inches from the eye, and directed obliquely towards the inner corner, so that there may be no chance of injuring it by an unlucky movement of the child, or from nervousness on the part of the nurse. The cries of the child must be disregarded, they merely indicate its dislike to the free movement of its head being restrained; the syringing produces no pain, and to some children the cool water clearly gives relief. Care should be taken that the clothes of the infant are not wetted. As soon as the cleansing of the eye is completed, a little vaseline or a drop of sweet oil may be swept along the margins of the lids with a camel-hair brush, and the little operation is complete. No bandages or cloths are required, as these only serve to keep the eye hot, and promote the flow of the discharge. The adoption of these simple measures suffices in a large number of cases to cure a troublesome and dangerous disease, and though in some instances the affection may linger for some time, yet it is satisfactory to feel that it is under control, and that no serious damage to the cornea is to be apprehended. No discouragement need be felt on account of a slight relapse after apparent recovery. The syringing should be recommenced, and it may be expedient to drop into the eye a little weak alum lotion, made by dissolving a fragment of alum the size of a Barcelona nut in a tumblerful of water. The ventilation of the room should be attended to, and the bowels should not be allowed to be confined. A word of caution may be added in regard to the person who syringes. The matter proceeding from the infant's eye is highly contagious, and the introduction of some of the spray spirted back from the eye has been not unfrequently known to set up acute and serious purulent inflammation in the person using the syringe. There is little risk of this, however, if the stream be not too violently forced out. The total duration of the disease is often six weeks or two months.

That purulent ophthalmia is of a contagious nature has long been recognised, and it has even been thought that the material conveying the infection has been obtained. In a severe epidemic of it that occurred in the course of the year 1866 in the Hôpital des Enfants, in Paris, the physician in charge, M. Giraldés, desired a gentleman well versed in practical chemistry, M. O. Reveil, to examine, analyse, and report upon the air of the wards; and the careful investigation to which this air was subjected showed that it contained globules of pus, together with scales of the skin, which were so dry and light as to float in it, or, at least, to be easily raised on the slightest disturbance of the dust on the floor, or on the admission of a current of air; and there is good reason for believing, as M. Giraldès suggested, that such germs, though desiccated, were not entirely dead, but when allowed to enter the eye, and placed under favourable conditions for germination, they might once more become active, and reproduce the disease of which they were themselves the offspring. This view is remarkably supported by experiments that have been made at different times with a view of establishing its inoculability by direct application of the matter discharged from the inflamed eyes to healthy eyes; for although it has been found that a healthy system is sometimes capable of resisting a minute dose of the virus, yet if a large dose be introduced, its poisonous properties are quickly manifested. It would appear also that the poison, when diluted with water, is much less effective than when pure ; and it is certain that thorough washing of the eye with warm water and a syringe greatly restricts or altogether prevents its effects. There is good reason for believing that the frequent relapses to which the children of the poor are liable are due to the practice of placing over the eyes bits of dirty rag, or sponging them with foul sponges, which actually convey the infection they are intended to remove. A small ball of well-carded cotton wool, dipped in pure water, forms the best sponge, and should be thrown away or, still better, burnt after it has been used.

If the infant escape during the first few days from inflammation, it is usually so well cared for that it is free from disease for some time, or, at least, suffers only from slight colds and catarrhs. One disease may, however, be mentioned which requires instant attention. This disease is cancer of the eye. It is recognised by a remarkable golden reflection from the pupil when the child is placed looking towards a moderately strong light, whilst the observer has his or her back to the light. It makes its appearance, in the great majority of cases, during the first few months of life, and if recognised sufficiently early, whilst it is still wholly limited to the globe of the eye, and promptly treated, the life of the infant may be saved. But this involves the hard alternative of removal of the eye. If observed, however, no time should be lost in obtaining a skilled opinion upon the nature of the case, since the only chance of preserving life is that the disease should be extirpated from the system before the seeds are implanted in other organs.

It need hardly be said that the general principles of hygiene should be adopted in children as in adults, if the eyes are to be kept healthy. Moderate exposure even to cold air in a well-nourished and healthy infant can be borne without harm, but cold draughts, dust, and bright lights should be avoided. The room in which the infant lives should be well ventilated, and the food, if brought up by hand, moderate in quantity, wholesome in quality, and always given at the same temperature.

The period of teething is perhaps that at which the next troubles of childhood in respect to the eyes are apt to occur. In many children the teeth are cut without a sign to mark the remarkable physiological process that is taking place, whilst in others it is a stormy period, the irritation of the sensitive nerves of the jaws radiating to many other organs and tissues, and leading to local spasms, general convulsions, and even to death itself. The management of the child at this critical period of its life will, however, be elsewhere considered; and it need here only be remarked that violent convulsions are a common cause of a peculiar kind of cataract, known as laminar cataract, which gradually increases in opacity till, at the age of from ten to fifteen, reading becomes difficult or impossible, and operative measures have to be resorted to. Every care, therefore, should be taken to tide over the period of teething without accident, and by a judicious system of diet, by exposure to fresh air, with clothing appropriate to the season, and by general attention, to prevent the occurrence of convulsions. If, unfortunately, cataract has been thus produced, it may be observed that it is not expedient to perform any operation for its removal during the first year or two of life; it is better to wait till the strength of the child is thoroughly regained than to operate too early.

We may now proceed to the consideration of two kinds of visual defect, the effects of which are usually apparent in childhood, and which it is of great importance to recognise early and treat appropriately, since, if neglected, they become the source of infinite trouble throughout the whole of school life, and may seriously interfere with the most important occupations of after years. We refer to long-sightedness and to short-sightedness, to which the technical names of hypermetropia and of myopia are applied, whilst there is still a third defect, termed astigmatism, to which no popular name has yet been given.

Each of these conditions is due to a defect in the form of the eye, in consequence of which the image of the outer world is not properly focussed on the retina, but either in front of or behind it; and as the path for the rays of light to reach the retina is otherwise clear, these cases are often termed cases of error of refraction. In the course of the last twenty years, the recognition of such errors of refraction, formerly greatly neglected, has become an important part of the work of an ophthalmic surgeon; and the application of glasses of various forms to remedy defects of vision arising from this cause occupies much of his time.

Long-sightedness, or Hypermetropia, and the Prevention of Squint.

Many children appear to have good vision during their infancy, and nothing occurs to excite suspicion that the eyes are not perfectly healthy until their education commences. It is then observed that after a short period of application a disinclination is manifested for further work; complaint is made that the eyes ache, or that reading or spelling makes the head ache. At first this is regarded as a mere piece of idleness. It is considered that the child, having got over the novelty of lessons, is becoming lazy, and should be made to work, and notwithstanding its reiterated complaints that it is unable to see clearly, it is treated with more and more severity. Parents or tutors are sometimes intelligent enough to suspect that the eyes are at fault, but not seldom the complaints are passed by unheeded; the child continues to be thought dull, or stupid, or not inclined for books, or incorrigibly lazy, though he may exhibit intelligence enough in all other respects. If, however, his complaints are disregarded, it is observed that after an hour or two of reading or writing, not only is pain complained of, but the eyes become visibly red and inflamed. A little secretion is poured out in the course of the night, causing the lids to stick together in the morning. Some difficulty is experienced in separating them, a gummy, crumbling matter having to be first rubbed away, and this proceeding, repeated on many successive mornings, leads to soreness of the margins of the lids, and to the condition known as blear eyes. It is remarked that when the boy is at home from school, at which time he carefully abstains from taking up a book, but engages freely in any out-door sports that may be open to him, he steadily improves, his eyes regain their natural aspect, and he goes back to school apparently well, but only to relapse into the same state as soon as work commences. This state of things—now better, now worse—may continue for years, in fact, till education is finished, the lad being incapable of protracted exertion, and usually taking but an indifferent position in the class.

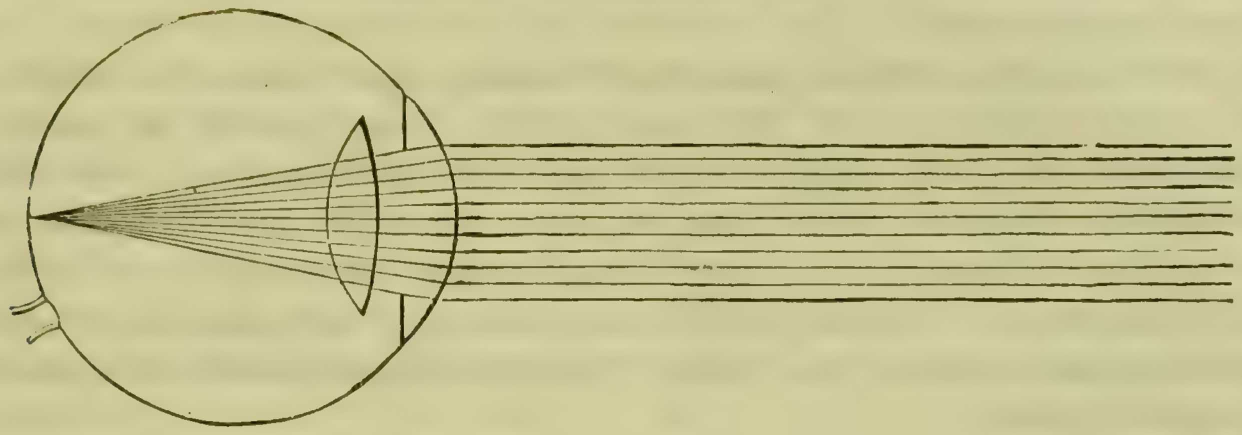


Fig. 4.—Healthy Eye.—Parallel rays brought to a focus on the retina when the eye is at rest.

We have seen that, as in Fig. 4, parallel rays of light falling on a healthily formed eye are brought to a focus exactly upon the retina, when the eye is at rest: that is to say, when no effort at accommodation is made.

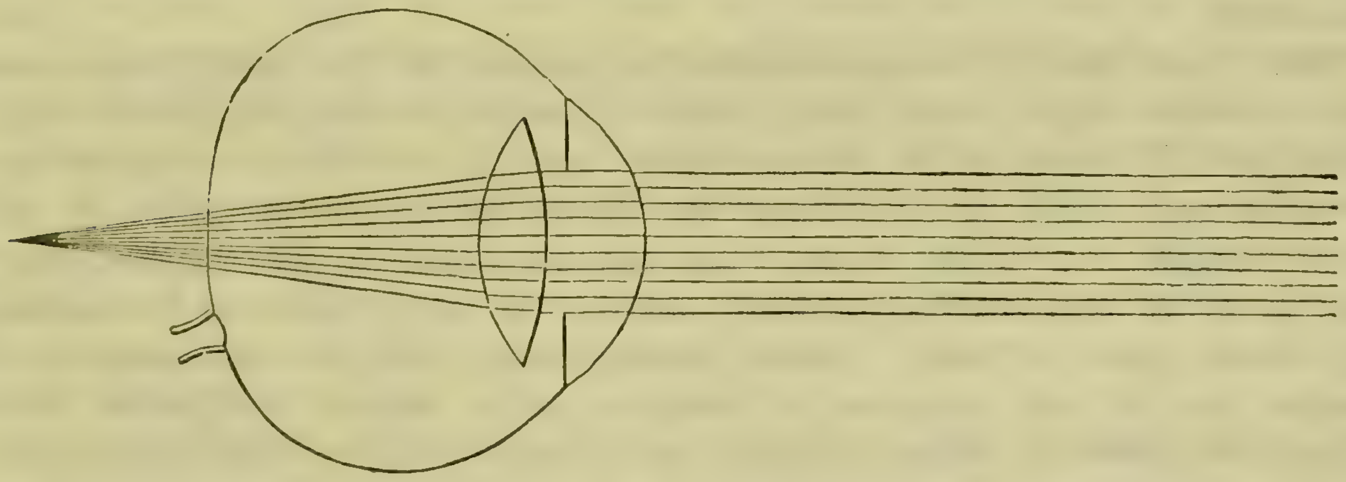


Fig. 5.—Long-sighted, or Hypermetropic Eye.—Parallel rays brought to a focus behind the retina when the eye is at rest.

A long-sighted eye is one in which parallel rays of light, or those which proceed from an object at some distance, and are therefore approximately parallel, are not brought to a focus upon the retina, but behind it, as in Fig. 5. This condition may result from one of two causes: either the lens may be too weak, or the distance between the lens and the screen on which the focus is formed—that is to say, between the lens and the retina—may be too short.

The usual cause of long-sightedness is, as shown in Fig. 5, that although the lens preserves its usual thickness, the distance between it and the retina is too short. The eye is a flattened eye. This alteration in the form of the eye has some very important consequences.

We have seen that when a person with healthy eyes looks at a remote object, no effort is required to see it. The rays of light being parallel, or nearly so, are brought to a focus on the retina without any muscular exertion. It is only when a near object is attentively considered, the rays from which are divergent, that the ciliary muscle is brought into play. That muscle makes the lens thicker, and causes it therefore to refract light more strongly, and consequently to bring divergent rays to a focus on the retina. But now let us consider the condition of a long-sighted person.

Every far-sighted person has to make an effort of accommodation when he looks at a remote object: in other words, when rays of light that are parallel, or nearly parallel, fall on his eye, he has to exert his ciliary muscle and to make his lens more convex, in order that the focus of such parallel rays should fall upon his retina. He is always exerting his accommodation, is always doing what the man with the healthy eye only does when he looks at some object close at hand. But muscular exertion implies a tax upon the nervous system, and, if long continued, more or less exhaustion. Supposing, then, that a long-sighted man were not to look at a near object at all, but to confine his attention to remote objects, he would at the close of the day be as tired, according to the degree of his defect, as a man with normally-formed eyes would be after reading a book at a moderate distance; if he is very long-sighted, as tired as a man would be with good eyes after reading many hours very small type, or as a woman would be who, with normally-constituted eyes, had been hemming or darning fine cambric or working cross-stitch.

But if an effort of accommodation be required for the parallel rays coming from a remote object, much more must he exert his accommodation when he has to turn his attention to a near object, and has to focus on his retina the divergent rays which proceed from the letters of a book, the notes of music, or the threads of a woven fabric. An immense effort is then required, for the lens has to be made strongly convex, and such an effort can only be maintained for a short space of time. Hence, although the child can see perfectly at a distance, he yet soon complains of headache and a sense of fatigue in the eyes if made to attend to minute objects; and hence it is also that he is unable to read for more than a few minutes at a time. If compelled to work, the violent effort required produces congestion and redness of the eyes, a larger flow of blood to them and to their appendages takes place, and hence watering of the eye and increased secretion of mucus. If work is still insisted on, dizziness and absolute inability to distinguish the letters of a book follow, and in some instances a feeling of sickness, or even actual vomiting, may be induced.

A circumstance which is often mentioned, and which occasions surprise, is that the child is worse in the morning than in the evening—worse, as it would appear, after rest than when making exertion; but this is easily explained. The sense of weariness experienced in the eye is of precisely the same nature as that which is felt in the limbs after a long walk has been taken. The muscles of the limbs and of the body generally are in that case exhausted, they retain in their tissues the materials of their own disintegration and decay, the flow of blood through them is tardy and feeble, and the attempt to use them on rising in the morning gives rise to a sensation of pain and aching, which does not pass off till the circulation through them has been re-established by moderate exertion after rest. Just so is it with the long-sighted eye. The child retires to bed with the muscle in a thoroughly exhausted state, especially if it has long evening lessons; during the night the muscle is at rest, but as soon as it begins to be exerted in efforts at accommodation on the following morning, it feels weary, and aches, and it is not till it has been fairly brought into play that it becomes supple and active.

Another symptom is often misunderstood; it is that when a book is given to a child to read, it begins to be remarked that it holds it nearer and nearer to the eye, and in many instances that it holds it to one side, or twists the head down to see the lines. The child is thought to be getting short-sighted, and, after due deliberation, is brought to an ophthalmic surgeon, who, after short inspection, pronounces it to be long and not short-sighted. Then why, it is asked, does it poke its head down close to the book? and the answer is simple. The effort which is required to make the long-sighted child see small objects at a moderate distance from the eye with distinctness is so great that when the attempt to read is made the muscle passes at once into a condition of spasm, contracting to its uttermost, to a greater extent even than is required to meet the conditions present. The luminous rays coming from the letters of the book are then brought to a focus in front of the retina, and in order to obtain a distinct image, the child brings the book closer and closer to the eye to render these luminous rays more diverging, and this, again, leads to greater spasm of the muscle, so that the affection has a tendency to intensify itself; and it can easily be understood that this condition of spasm or cramp of the ciliary muscle is attended with pain. The disposition to look sideways at the book is probably best explained on the supposition that a difficulty is felt in bringing the muscles effecting convergence of both eyes into play, and, after a time, one alone is actively engaged in the effort of accommodation, and the book is naturally placed in front of the eye by which the clearest images are received.

But occasionally another symptom arises as soon as the child is made to apply himself to books. He begins to have a cast in the eye—that is, to squint. At first this is occasional; it is only observable now and again, when the attention is strongly excited, and it may be difficult to determine which eye has the cast, but soon it becomes persistent, and the most absurd ideas are often entertained in regard to the cause of this affection. The nurse, it is said, has arranged its hair so that a particular curl constantly attracts its attention, or it is thought to result from imitation of an older child who is also affected. The real cause in most instances is that the child is long-sighted, and it is not difficult to explain the mode in which squint arises from long sight. A muscular effort has to be made in order that the eyes should converge upon any near object, and there is a very perfect harmony between the degree of accommodation and the amount of convergence, both being, as a rule, increased or diminished together; and, in accordance with this, the two recti muscles outside the globe which rotate the globe of the eye inwards and effect convergence, and the internal or ciliary muscle which, by its action, renders the lens more convex and effects accommodation, are supplied by the same nerve—the third cerebral nerve. Hence, when a long-sighted person looks at a near object, impulses issue from the brain, which are directed to the ciliary muscle and to the internal straight muscle of the globe ; but the demand for accommodation in order that clear images should be obtained is excessive, and hence it appears probable that a stronger impulse than necessary is transmitted to the internal rectus, and, as a result, an inward squint is gradually developed. At first the squint is only slight and occasional, and often in one eye only, though alternation of the cast is also frequently observed; but soon it becomes more and more confirmed. The best formed eye of the two—the one, that is to say, which is least hypermetropic—is systematically used, whilst the other is neglected, and the disused eye becomes permanently inverted ; sometimes the two eyes are alternately affected.

These considerations will afford an explanation of various symptoms that are familiar to all those who have a tendency to squint. It is observed most when the child is exhausted and debilitated; and hence before meals, or after a fatiguing walk, or after a dance and late sitting up, after diarrhœa, and during convalescence from any infectious disease, such as measles or scarlet fever. At such times the whole nervous and muscular system of the body, and, therefore, the nervous and muscular apparatus of the eye, is enfeebled. A more than usually powerful impulse has to be sent down from the brain to effect accommodation, and the internal recti muscles are consequently inordinately excited to contract, and, in addition, their superior power enables them at such times to triumph more easily over their antagonists.

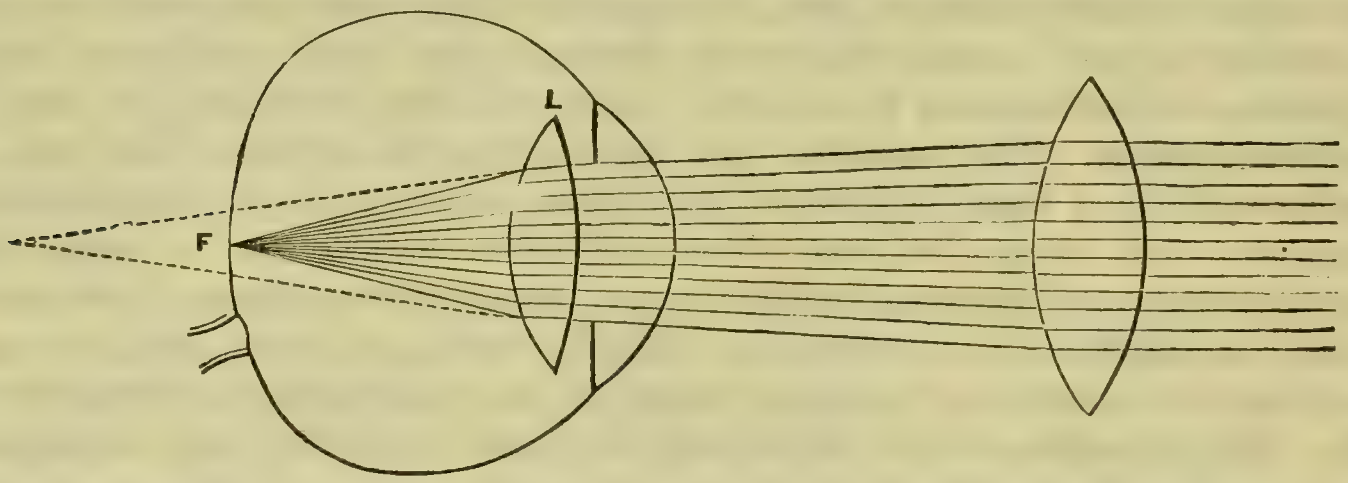


Fig. 6.—Hypermetropic Eye. Parallel rays, as indicated by dotted lines, come to a focus behind the retina. By the use of a convex glass parallel rays, being made convergent, are focussed on the retina.

The question then arises, How are the two conditions of weariness and exhaustion of the eye, with the attendant symptoms and squint, to be prevented?

The answer is, By the selection of appropriate glasses—of glasses just strong enough to enable the lens, without unnatural effort, to bring parallel rays to a focus on the retina (Fig. 4); and it is of great consequence that such glasses should be given, for many of the symptoms complained of by long-sighted children are at once and permanently removed. The ciliary muscle, no longer strained, ceases to give pain; reading or sewing can be continued for an hour or more without discomfort. No congestion of the eye follows even prolonged exertion, because the glasses have placed the eyes of the patient in the same condition as regards accommodation as those of a healthy person. As there is no congestion, no increased flow of blood to the parts, the secretions of the eyes are lessened; there is no tendency to the adherence of the lids in the morning, no gummy secretion to be cleared away; and, which is a matter of far greater importance, both eyes are brought equally into play, and the disposition to squint is removed.

It cannot be too strongly stated that any tendency to squint that may be observed in a child of from four to seven years of age should receive immediate attention. Such tendency is, in a large majority of cases, simply due to some error of refraction, which is capable of being remedied by the selection of appropriate glasses; and not only do spectacles greatly relieve the work of the eye, but they may actually prevent the occurrence of squint, and effect the preservation of good vision in both eyes throughout life.

No fears need be entertained in respect of danger to the eyes from the breaking of the glasses. They are placed in such close proximity to the eye that the child instinctively shrinks from anything that would injure them, as he would from anything threatening the eye itself, and there is no record of any accident from this cause.

A nervous twitching is often seen in children. At first the eyes are closed more frequently than natural; then the winking becomes more energetic, the lids being tightly pressed together. Other muscles begin to participate in the contraction, and a spasm passes across the features, the corners of the eye being wrinkled, the eyebrows drawn down, and the mouth drawn up with a kind of grin, which disappears in a moment, to be repeated after a short interval. The attacks are more common after reading. These symptoms sometimes depend on brain disease, and then are serious; but far more frequently it is only a consequence of long sight. As has been explained, to see near objects distinctly an effort is required: a nervous impulse has to be sent down from the brain to the eye. And this impulse, or the effort to make it, is very distinctly perceptible even in the healthy man, but the unusually powerful effort the long-sighted child has to make renders the nervous impulse apt to radiate or discharge itself through other channels: to affect, that is to say, other nerves outside the eye; and the result is seen in the spasmodic action, first of the muscle closing the eyes, then of the muscle raising the angle of the mouth, and sometimes of many other muscles. The twitching in this case closely resembles stammering, and, like that defect, occurs in feeble, ill-developed, and ill-fed children. In stammering, the nervous impulse intended for one muscle passes down other nerves, and brings other muscles into play. The adoption of appropriate glasses, if commenced at an early period, and before the habit has become fixed, will often cure this twitching affection, especially if due attention be paid to the general health and to the development of the bodily powers.

NATURE AND CAUSES OF MYOPIA, OR SHORT-SIGHTEDNESS.

The uneducated man, in common with animals, uses his eyes for the perception and intelligent recognition of distant rather than of near objects. The shepherd tending his flocks on wide steppes or plains, the hunter pursuing the deer or the buffalo, the seaman in his canoe or bark—all have their attention fixed on distant objects, and for short periods only accommodate them for near objects; and even the occupations of women in illiterate nations, such as spinning and knitting, make little demand upon the muscular system of the eyes; but as civilisation develops, as a knowledge of letters becomes imperative, as manufactures become more numerous, and the products of art more delicate and refined, as hemming and stitching and fine tapestry-work take the place of the coarser kinds of work done by women, sedentary occupations become more numerous, and the eyes are more and more severely tried.

The conditions for the obtainment of food, that prime mover to all exertion, are reversed. The savage loses his dinner if his distant vision is bad; the artisan of the present day has little chance of obtaining his if his vision for near objects is impaired. But, in proportion as the eyes are exerted upon near objects, they tend to become specially adapted for that kind of work. Vision for distant objects becomes impaired, whilst vision for near objects is improved, and the condition termed near- or short-sightedness, the technical name of which is myopia, is developed.

Myopia may be defined as that condition of the eye in which parallel rays of light are brought to a focus in front of the retina, or, in other words, that condition in which, in order that an object should be distinctly seen, it must be brought within a certain measurable distance from the eye, to a distance, in fact, at which the luminous rays proceeding from it are so divergent that they exactly focus on the retina; and this point is called the far point. If the object be removed to a greater distance than the far point, the rays of light proceeding from it are focussed in front of the retina, and crossing, form a blurred and confused image upon it.

The greater or less distance of the far point from the eye constitutes the higher or lower degree of myopia, and a rough judgment of the degree of myopia present in any given case may be formed by noticing the position in which any person holds a paper with intent to read, or attempts to thread a needle. In extreme degrees of myopia the patient sometimes almost sweeps the page with the nose. Myopia is assisted by concave glasses, because concave glasses cause the rays of light that traverse them to diverge, and the depth of the glass that is required to give a clear image of a distant object furnishes the measure of the myopia present in any given case.

The accompanying diagrams will render the nature of the physical changes that are present in myopia intelligible. The healthy eye, as has been already explained, may be regarded as of nearly spherical form, and parallel rays, or those coming from very remote objects, are, as in Fig. 4, brought to a focus when the eye is at rest exactly upon the retina; but the typical form of the myopic eye is elongated, more or less egg-shaped, and as a necessary consequence, the structure of the other parts of the eye being unaltered, rays of light coming from very remote objects are, as in Fig. 7, brought to a focus in the vitreous humour, as at F, at a certain distance, varying with the degree of myopia, in front of the retina. The image thus formed is necessarily blurred and indistinct, for the rays of light, after uniting in the focus (F) to which they have converged, owing to the action of the lens upon their direction, cross one another, and form a circle of dispersion on the retina. A person with healthy eyes may acquire a good idea of the appearance which the world presents to a short-sighted person by looking through such an ordinary hand lens as that used for examining pictures, placed close to the eye. Under these circumstances, all objects in a room become ill-defined; the form of a picture-frame, the broad differences of light and shade, the colour of the dress worn by a lady, may be readily distinguished, but the details are invisible, and the degree of impairment of the clearness of the image is directly dependent upon the strength of the glass used, exactly as in myopia the indistinctness of vision is in direct ratio to the elongation of the globe of the eye : the longer the axis of the eye from before backwards the worse the vision.

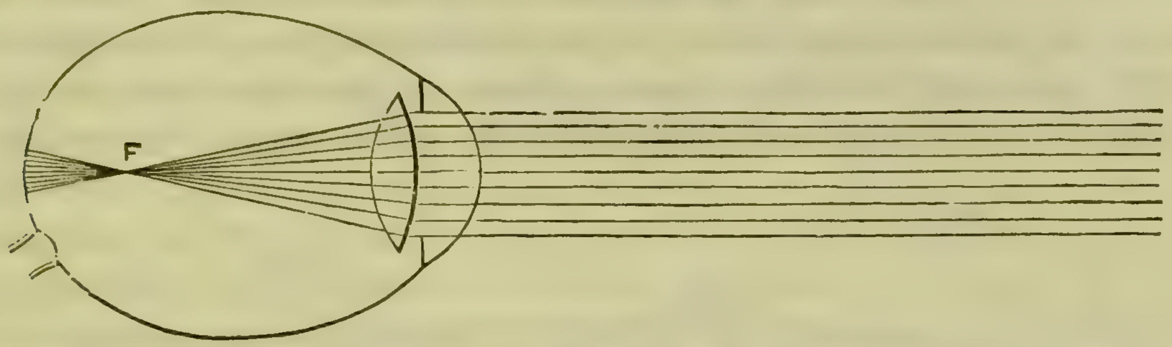


Fig. 7.—Short-sighted, or Myopic Eye. Parallel rays falling upon it brought to a focus (F) in front of the retina.

It is obvious that just as the lens placed in front of the eye brings parallel rays of light to a focus too early, so a similar condition is established if the lens in the eye itself be too strong; and it may occasionally happen that this is the cause of myopia, but it is probably rare, and the elongation of the axis of the globe must be regarded as by far the most frequent cause of the defect.

If the expression may be allowed, there are cases of healthy and of unhealthy myopia, or rather, some cases of myopia are much less liable to complications which seriously impair vision than others. Thus, some myopic eyes are smoothly and evenly elongated, their outline is regular, and the back surface resembles that of an egg in the uniformity of its curve; but others are irregular in form, the elongation is not uniform, but is obtained at the expense of some particular part usually that immediately surrounding the entrance of the optic nerve, and the back part of the eye, instead of being smooth and rounded, presents bosses and projections similar to those that are often seen near the footstalk of a large lemon. The difference in the prospects of the two sets of cases is considerable, and is easily intelligible. In the one case, the blood-vessels of the retina and choroid, if somewhat stretched, are yet elongated evenly, and with no varying strain; whereas, in the other case they are tortuous and irregular, and as the disease advances, are irregularly strained, and are hence apt to give way or to become the seat of disease.

The mode of treatment adopted for the relief of myopic eyes is to place in front of the eye a concave glass.

This form of the glass causes parallel rays of light falling upon it to diverge. Such divergent rays will not be brought to a focus so soon as parallel rays, and the object is to give glasses of just such strength as shall compensate for the increased length of the axis of the eye, and bring the rays to a focus on the retina. This is shown in Fig 8, where the parallel rays, falling on the bi-concave lens in front of the eye, are rendered divergent, and therefore come to a focus on the retina, and not in front of it, as in Fig. 7. It is important that the glass given should not be too strong, because if the rays of light are made to diverge too much the focus will fall behind the retina, and an effort of accommodation is required to bring the focus up to the retina—an effort that is always injurious to the eye. The myopic patient should, therefore, use the weakest glass with which he can see tolerably well. It is better to err on the side of insufficient strength of glass than to use those that are too strong.

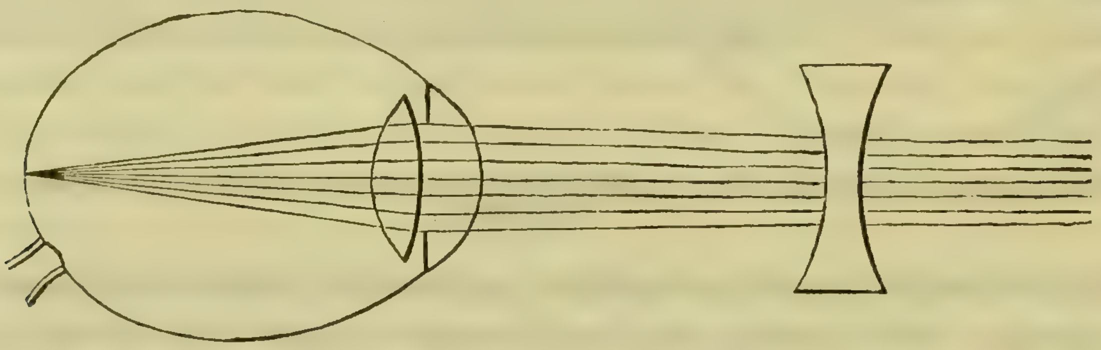


Fig. 8.—Myopic Eye, the vision of which is rendered perfect by the use of a concave lens.

The prevention of the spread of myopia is a subject of national importance; and since it is an affliction that is apt to be developed in childhood, and can certainly, if originally present, be greatly intensified by the method in which education is conducted, it fairly falls within the scope of this work to explain the mode of its production, and the means that should be adopted to prevent its occurrence or to stay its progress.

Once formed, moreover, there is no condition of the eyes which demands more frequent attention, which is more likely, as the child advances to maturity, to interfere with its progress in life, or which is more frequently the precursor of serious, and oftentimes irremediable, impairment of vision. Nor is there any defect in which the chance selection of glasses may produce more serious damage, or in which skilled advice may prove of more signal service to the sufferer in preventing the accidents to which every myopic eye is liable.

In England, happily, it is as yet a rare disease, but in France it is common, whilst in Germany it has of late years become so frequent as to have attracted the attention not only of professional men but of the State authorities, and to lead to enactments which it is hoped may ultimately effect its extinction. Unfortunately, however, it is an hereditary disease, or at least there is a strong hereditary tendency to it; so that the children of myopic parents develop this affection under circumstances in which a healthy child, or one descended from healthy parents, would suffer no injury.

As a matter of fact, it appears that few children are born short-sighted, but they become so as soon as their attention is directed to minute objects: that is, as soon as their education begins; and the more minute the work, and the closer and the more protracted the attention that is given to it, the more rapidly does the malady progress. At the age of twenty or thereabouts in a large proportion of cases, partly through the increasing firmness of the tissues, and partly owing to the cessation of education, myopia becomes stationary, but when severe work is continued beyond that time, it still increases, and may continue to develop almost throughout life. Its course is, however, somewhat modified by the natural changes that take place in the eye with advancing age. The freedom of the English race from myopia may be regarded as in great measure due to the habits of their ancestors for many generations past. Their Danish and Saxon forefathers lived on the sea or in the open air, following the plough or dancing over the blue waters of the Northern Sea. Distant objects attracted notice, manufactures were few in number, and of workmanship involving close examination there was little or none. The imperfection of the means of lighting at night, the absence of books, the ignorance of letters, both amongst the nobles who scorned them and amongst the poor who had not the means of acquiring them, led to drinking and the telling of stories, to the wassail bowl, and the song of Cædmon, but also to early rest, long sleep, and—not the least advantage—to a healthy form and construction of the eyes. And if outdoor occupations were followed by the men, the labours of the women were not of a kind to seriously tax the visual powers. Spinning and knitting, the weaving of coarse clothing required but little attention, and are at the present day actually regarded as occupations well adapted for those whose vision is failing from age or infirmity.

It has been stated that myopia is hereditary, but it is also an affection that can be acquired, and this fact has an important bearing on the whole system of education, and upon almost every part of it. The age at which education should be commenced, the time during which it should be continued, the position of the child when learning, the books that should be put into his hands, and the general surroundings in regard to light and ventilation, are all points requiring and fully repaying careful consideration and research.

Attention was first directed to the remarkable development of myopia during school life by Jäger, in 1861, whose observations were, however, made upon comparatively few children. The subject was soon afterwards taken up by Cohn of Breslau, who examined more than 10,000 scholars, and who was able to deduce some very remarkable conclusions from his observations; for he found, in the first place, that the children attending rural schools were almost free from short-sightedness, but that the affection increased in frequency in proportion to the demands made upon them, attaining its maximum in the gymnasia; secondly, that the number of myopic children, proceeding from the lower to the higher classes in all schools, was augmented in a regular and uniform manner; and lastly, that the degree of myopia increased from class to class, so that not only were there more myopic youths of both sexes in the higher classes, but the imperfection of vision consequent on the degree of myopia was much greater in the higher classes than in the lower. Cohn's observations have been repeated in Germany, in America, in this country, and elsewhere, and in every instance with confirmatory results. As regards the actual numbers, Cohn found that in the rural schools of Germany one child in every hundred was myopic; in the elementary schools there were from five to eleven in every hundred; in girls' schools, ten to twenty-four; in the royal schools, twenty to forty; and in the gymnasia, thirty to fifty-five in every hundred. The proportion of myopics amongst the students in Breslau was found by Cohn to be 60 per cent., and amongst the medical students 56 per cent. in 1867 and 57 per cent. in 1881; and he has noticed that in the first year of study the proportion is 52 per cent., whilst in the last year it has risen to 64 per cent. He goes so far even as to suggest that a term for this special form of myopia should be instituted, and that it should be named the myopia of examination. At Tübingen, Gärtner found that amongst 600 students pursuing theological studies the number of myopics was 79 per cent.

The subjects taught in the gymnasia are classics, French, English, mathematics, natural science, history, geography; and the number of these schools is very large, being no less than 360, or about one to every 117,000 of the population. In the Realschülen no Greek is taught, though the curriculum is otherwise similar, and of these there are 129. In the Gewerbeschülen no languages are taught.

In the schools of all countries it has been found that, as at Breslau, the number of myopics increases in passing from the lower to the higher classes, till it reaches a frightful number during the last two years of study at the gymnasia, the average number oscillating between 35 and 60 per cent., whilst it still continues to increase if the lad goes up to one of the universities, rising to 64 at Breslau, 75 at Magdeburg, 80 at Erlangen, and Heidelberg heading the list in some classes with 100 per cent. Cohn, indeed, remarks that so prevalent is myopia amongst the Germans that in one of the International Medical Congresses he had no hesitation in hailing any member as a compatriot and addressing him in the German language if he wore strong myopic spectacles.

In like manner, Zehender, the learned professor of ophthalmology at Rostock, examined the scholars of the gymnasium at that place. The number of scholars was 314, and there were no less than 30·57 per cent. of myopics amongst them, which were distributed as follows amongst the different classes:—

In the lowest classes	10·9 per cent.
5th class	16·0 „
4th B	31·03 „
4th A	35·45 „
3rd B	33·33 „
3rd A	40·0 „
Lower 2nd	47·82 „
Upper 2nd	33·33 „
1st	41·38 „

In addition, there were 36 whose eyes were weak.

The remarks here made must be regarded as referring to the past rather than to the present, since the Germans have themselves been the first to notice the alarming development of myopia, to experience the evils that it entails, and to study its nature and causes, and under the influence of numerous pamphlets, popular lectures, and scientific treatises, the public have become enlightened on the subject, and immense improvements have taken place in every detail of school life—improvements which, if they do not effect the complete removal of the disease, will yet exert a powerful influence in preventing its extension and limiting its degree.

The general standard of knowledge amongst the Germans is, of course—as a result of the work done in the schools—far higher than amongst other nations. Thus the proportion of illiterates, or people unable to read or to write, is only 1 per cent. of the whole population; whilst in England, as lately as 1865, 34 per cent. of the Marines could neither read nor write, 4 per cent. could only read, and 37 per cent. could only write imperfectly. Yet the Marines are a fine body of men, chiefly drawn from the rural population. In certain parts of Germany general education is still more widely spread, for it was found that in Würtemburg only one recruit in 6,000 was unable to read or write, whilst in England there would have been at the date referred to no less than 2,240 in 6,000 quite unable to do either.

The institution of our Board Schools has, no doubt, greatly diminished this proportion, and most of the children of the lower classes will in a few years be able to read and write with moderate facility; but whilst no intelligent ophthalmic surgeon will inveigh against the acquirement of the rudiments of literary knowledge by the poorer classes, since, if properly directed by a wholesome tone of the daily and weekly press, it is sure to produce good fruit, it must always be borne in mind that its tendency is to develop myopia, and through myopia many other affections of the eyes.

In France, in 1833, as we learn from the reports furnished by Lorraine and the first visitors of schools appointed by M. Guizot, the school charges depended on whether the pupil was taught reading alone or reading and writing; and many children left school incapable of writing even their own names, and of those who could read some could only read print, whilst others could decipher writing. It is even said that in some cantons of Brittany, of the Limousin, and of Cevennes, there are schools where no writing is taught until the children can read easily and know their Catechism. In many of our own schools *good* writing is almost ignored, and boys are allowed to send up almost anything they please. The habit of setting impositions in which 500 or 1,000 lines have to be written out for some trivial fault is to some extent responsible for this; and examiners and all who have a large correspondence know how much of the writing of the present day supplies evidence of bad teaching in the irregular inclination and imperfect formation of the letters, individual words being often quite illegible, unless the reader knows something of the subject, and can guess at them by the context, or that part of the context which he can make out.

It is certain that the number of myopes is much less in other nations than amongst the Germans. Thus observers in New York, amongst whom Derby, Loring, and Agnew may be mentioned, have not found more than from 4 to 27 per cent. of myopes between the ages of 6 and 21 in the schools of America, and in Russia it varies from 11 to 44 per cent. between the same ages; but Derby noticed a considerable increase in the number of myopes amongst medical students after only four years of study, and similar observations have been made by Reuss at Vienna and, as already stated, by Cohn at Breslau. The latter observer states that he examined all the students at the Frederick Gymnasium at two periods, with an interval of about two years, and found that in the course of that period no less than seventeen who had previously good vision had become myopic, whilst those who were previously myopic suffered an increase of their defect.

As in Germany short-sightedness is most common, and as sufficient evidence has now been advanced to show that this affection is most prone to develop during the period of education, it is natural to turn to that country with the view of investigating the mode in which education has been conducted, as compared with that of other countries, and of profiting by those infractions of the broad rules of hygiene that are applicable both to the body at large, and to the eye in particular, that may be ascertained to have been in operation in that country; for it is reasonable to suppose that similar errors are to a great or less extent practised in every other country where myopia is prevalent.

The causes at work in producing myopia—or, as they may be termed, the factors which have been fairly ascertained to exert a powerful influence in the development of the disease—are prolonged exertion of the eyes upon near objects, inadequate amount of light, bad form of type, indifferent paper and printing, and insufficient physical exercise and food.

Want of exercise and of food do not in themselves cause myopia, but must, nevertheless, be regarded as powerful predisposing causes; for, in the first place, vigorous exercise tends to strengthen the various coats of the eye, in common with all other parts of the body, and thus prevents them from yielding to internal pressure, whilst it also prevents local congestions of blood, and fulness of the blood-vessels in the head in particular, by calling the blood to the limbs and muscles employed in the acts of progression or in gymnastic exercises; and secondly, those who are engaged in sedentary occupations necessarily employ the eyes on near objects, which it will be shown directly is one of the most potent causes of myopia.

Physical exercise is acknowledged by the best instructed Germans to be remarkably deficient amongst German boys. One writer in particular expresses in warm terms the astonishment he experienced in witnessing, on a visit to England, the large numbers of youths of all classes who may be seen in Battersea Park and other open spaces playing at cricket and other games, and the, to him, surprising interest taken in such games by the bystanders. He notices the crowds that assemble to see the Oxford and Cambridge boat-race, and observes that it is impossible to conceive that they would take the trouble to go so far for the momentary glimpse they obtain of the race, were it not that they felt an interest in it from personal knowledge of the art of rowing. "We laugh at their folly," he continues, "because we cannot emulate or practise it."

The amount of food given to German children, although simple and plain, is probably sufficient for all the purposes of nutrition, though it probably has the fault of being a little too monotonous or wanting in variety.

In Germany the school hours vary from four to six daily, and home tasks are given which require at least as much work : that is to say, the boy has to sit at his books and accommodate his eyes for near objects for a period varying from eight to twelve hours daily, almost without interruption.

In regard to illumination, the amount of light supplied in schools in Germany was probably, up to a recent time, insufficient. The Germans are a thrifty nation, live economically, and if the statements of such German boys as come to this country may be relied upon, no more than one candle was formerly allowed to every six, eight, or even ten boys.

Lastly, no one can inspect the German books of fifty years ago, whether school-books or the dictionaries intended for adults, without being struck with the singular roughness and inequality of the paper, and the difficulty of deciphering the old Gothic type, which was made still more illegible by the bad ink with which it was printed.

There can be little doubt that these causes have collectively conspired to render the Germans a nation of myopes, and it follows that the defects which have been pointed out should be carefully avoided; and we shall venture here to give some further details and suggestions upon each of these points, with the view of maintaining the general standard of vision at present possessed by English children.

No observations need be made in regard to exercise, as physical exertion of every kind is encouraged to a sufficient extent in all public and in most private schools.

That the requirements of work at English schools both for boys and girls are gradually rising, that more and more is required of them, is well known, and the lists of subjects cannot be read over by any one familiar with children without feeling that either much of the work must be scamped (which is probably the case, or we should have more myopes amongst us) or that the scholars are worked at high pressure, and that the effects are likely to be injurious. At some boys' schools there are three half-holidays in the week, which is an excellent arrangement, and probably, even in those who work hard, saves many from visual defects, especially as the games are such as for the most part require distant vision.

Our arrangements for very young children are perhaps the worst. Half-an-hour or three-quarters of an hour is as long as a child of six or seven can devote his mind to any object, and he should then be allowed a rest; and it would be well if in English schools more use were made of the black-board and chalk, as is customary in Kindergarten establishments.

Since, on the one hand, the employment of the eyes on minute objects for any length of time is injurious, and, on the other, education which renders such employment of the eyes compulsory must be pursued, it follows that the amount of work that any child is called upon to do must be of the nature of a compromise between the two; and perhaps the best compromise that can be made is that work should not be carried on unintermittingly, but that it should alternate with periods of rest—that mental exertion should be relieved by bodily exercise. Children should rise early, especially in summer, and may fairly be called upon to do an hour's work before breakfast, providing they have a cup of milk with half a slice of dry bread. It is not right to require any mental work from a child who has just waked up, and who has a perfectly empty stomach. Children especially between the ages of ten and sixteen, when demands of this kind are often made upon them, are growing rapidly, and not only absorb, but use up in the constructive acts all the food ingested on the previous evening, and probably also much of that which is in reserve in the blood; and to compel mental work before any food is taken is to make a serious demand upon the vital powers.

And work should not be demanded from a growing child immediately after food. The acts of digestion require a large supply of blood, and so long as these acts are in progress the rest of the system, and the brain in particular, must be comparatively bloodless, or if it be brought into play, it diverts a certain quantity of the blood from its proper destination, and interferes with the due assimilation of the food. An interval of rest, then, is necessary after breakfast; but if this be taken at eight a.m., school work may well be commenced at nine, and vigorously prosecuted till twelve. At some schools, and upon sound physiological principles, a rest from lessons and a run for a quarter of an hour are allowed at eleven. The period between twelve and one should be spent in play. Dinner, consisting of plain roast or boiled meat and a farinaceous pudding, may occupy half-an-hour, and after a short interval for digestion school work may be resumed for two hours. The evening or home lessons should be light, and should not make a greater demand upon the child's time than three-quarters of an hour, and he should go to bed at nine. Children should be helped with their lessons, at all events when they first attend school, and they should be taught the immense saving of time that is obtained by close attention for a short period. All loitering and inattention should be discouraged. A child in whom habits of attention have been cultivated will learn more in half-an-hour, and learn it more accurately, than an inattentive child will do in treble the time, and all time so saved reduces the period during which active accommodation of the eye is required. It may just be noticed also that many children will learn by oral instruction—a method far too much neglected in our schools—with great rapidity, and more intelligently, than if set down to books and told to learn a lesson by heart. But few parents have the time to devote themselves systematically in the morning hours to their children, and tutors and governesses are apt to be discouraged if they find a child is stupid and inattentive at first, and they commonly take no pains to discover the method by which its interest may be excited. No doubt can be entertained, however, that if the relatives can devote themselves to the education of a child with a strong tendency to myopia, or are wealthy enough to procure the services of others who will take an interest in their work, it is better to conduct the education by means of oral instruction rather than by book work; and, in the case of a girl, fine sewing and other kinds of feminine occupation entailing very close examination with the eyes, should not be insisted upon.

The *rationale* of the production of myopia under these circumstances is that the sclerotic coat of the eye in children is comparatively soft and yielding, and that the muscles effecting the convergence and accommodation of the eyes required for the clear vision of minute objects exert a kind of pressure on the globe, which causes its elongation; and it follows that the longer the hours of work, and the closer the application, the greater is the deformity of the eye that is induced.

As it is the exertion of the eyes on minute objects at short distances that really tries their powers, and in many instances leads to trouble, especially if they are not quite healthy, it is clear that the arts of reading, writing, sewing, and music, in the acquirement of which much of the accommodative work of early life is done, should be practised under those conditions which experience has shown to be most favourable, and that, as far as possible, the objects themselves should be well-illuminated and defined. The quantity of light admitted into a schoolroom should be a point of the first consideration; for, although a moderate or small amount of window-surface may give sufficient light to enable children to read, write, or sew with ease and comfort in the middle of a bright summer day, it may be seriously defective in the darker days of winter, and especially in the afternoon, inducing the children to stoop over their lessons, and to strain their eyes by close inspection of their work. It has been ascertained that in schools where lighting is defective, other things being equal, myopia is most prevalent; and the rule has been laid down that window-surface should be one-fourth or one-fifth of the floor-surface. This proportion is ample in the case of a house standing apart, or for the upper stories of a town house; but it should be borne in mind that in towns much of the sky, which alone affords the requisite supply, is cut off by the opposite houses. Properly, the space between the schoolroom windows and the neighbouring houses should be twice the height of the adjoining buildings, though few streets in London and other large cities fulfil this requirement. The light admitted by a skylight is good, since it falls vertically on the paper and illuminates all parts alike, but it can only be obtained in exceptional instances, and rooms so lighted are dull and uninteresting, and give the impression of being in a well. It is generally admitted that light should enter from the left side. The advantage of this in writing is obvious, for the strokes made with the pen are at once seen; whereas, if the light enter from the right, they are to a certain extent concealed and in shade. Front light, especially if to the south, is dazzling, and in the event of a sloping desk being used, causes the writing or text to be in the shade; and light entering from behind is necessarily obstructed by the body and head; and neither of these, consequently, is so good as light entering from the left side.

During the long afternoons and evenings of winter some kind of artificial light must be used, and the choice in schools usually rests between gas and candles—gas being generally selected on the several grounds of safety, cleanliness, and economy. Gas, however, spoils the air to a much greater extent than other means of illumination, not only using up more oxygen, but yielding by its combustion a considerable volume of sulphurous acid and other gases, which are extremely deleterious, even in small quantities. The effects of these gases are quickly shown in conservatories by the drooping of plants, and make themselves apparent in our rooms by their action on the leather binding of books. The fish-tail light is apt to flicker, though with a Sugden's burner and shade it can be made sufficiently steady.

If candles are used, there should be at least two to every four boys. For home work, a kerosene lamp will be found very serviceable. It should have a dark-green shade to protect the eyes, with white internal surface to reflect the light on the book. But, as already remarked, the lessons done at home and in the evenings should be short. A healthy child, from ten to fourteen years of age, who has risen at 7 a.m., and has pursued a proper system of education during the day, is not in a condition to begin serious study at seven at night, or at least to do more than an hour's work; and if the exigences of modern examinations will allow of it, the evening is the time for relaxation and pleasure.

Again, although good illumination occupies the foremost place because it is essential for giving definition of external objects, yet it is of scarcely less importance that the objects themselves should be, as far as possible, clearly cut and well defined, and should give no unnecessary trouble to the eye and brain in acquiring a knowledge of them. It cannot, therefore, be regarded as a matter of small importance to consider what forms of printed books and what kinds of sewing should be presented to young children, and on these points much interesting information has been recently obtained.

It may be stated, as a general rule, that the books given to children to read, and especially those that are given to them to acquire a knowledge of the art of reading, should be of large, clear type, and should be printed on good paper. In this respect the Roman type of the present day is a manifest improvement upon the Gothic type, which, up to a recent period, was in common use throughout Germany. The Gothic type was employed by the earliest German printers to make their books resemble the contemporary manuscripts; and it is believed by some that the Roman, or Latin, type, as we call it, but which is termed "antiqua" by German and other printers, was the creation of Italian humanism, and was adopted as representing at once a close approximation to the character of the antique classics and rebellion against the monks, from whose manuscript character the Gothic was derived. Javal has demonstrated that, in reading, the eye travels along a horizontal line just below the upper extremity of the letters which constitute the words, and this movement is made in accordance with our Western mode of printing and reading in horizontal lines from left to right, and to avoid useless and complicated movements of the eyes. If the upper half of a line of print be covered with a sheet of opaque paper, we shall find that it is difficult to make out many of the words, and almost impossible to read fluently; whereas, if the lower half of the line be covered, and the upper extremities of the letters be alone seen, it is easy to read the line; and this may be attributed to the greater number of letters that are prolonged above the line as compared with those below. Thus, of the former we have b, d, f, h, k, l, t, and the dotted i, whilst amongst the latter we have only g, j, p, q, and y; and taking the relative frequency with which these letters are used, together with capitals, and in some languages, as the French, accents, we find that eighty-five marks are above the line, for fifteen below, in every hundred, and to this circumstance is due the fact that every reader runs his eye along the letters a little below their upper extremities. In typical forms of type, the letters should be as distinct as possible from each other, so that no difficulty may exist in reading them. This is especially the case with the h and the b, the v and the n. But these are not the only points that demand attention. The thickness of the down-strokes and of the up-strokes, the spaces between the letters, the spaces between the words, the space between the lines, and the length of the lines themselves, are all points of interest, and have all received consideration at the hands of printers.

The following words represent well-known sizes of type:—

Brilliant.	*Pearl.*	*Minion.*	*Bourgeois.*	*Small Pica.*	*Pica.*	*Great Primer.*	*Double Pica.*
The trivial	round, the	common	task, will	furnish	all we	need	to ask.

It may be said that no type smaller than Pica should be used to teach children to read; but when they have once acquired the art, the size may be considerably reduced. Cohn proposes that the type of ordinary journals should be 4 mm. in height, which is equivalent to $\frac{1}{6}$th of an inch; but M. Javal thinks that it may be allowed to diminish to 2 mm., or $\frac{1}{12}$th of an inch.

The list of conditions is not even yet exhausted, for as there are varieties of type, so also there are differences of printing, and although the ink is rarely at fault, yet the unpleasant effects of letter-press obtained from an old and worn-out fount, and resulting in imperfect impressions of the individual letters, are familiar to every one. In such cases the loops of the a and e, of the b, d, p, and g, are apt to become foul, and form a black spot—"monks and friars," as they are termed; the long letters become broken and the fine up-strokes imperceptible, and these imperfections are much increased by roughnesses and inequalities of the paper, which may also have the additional disadvantage of being porous.

Each of these conditions increases the difficulty of learning to read—an art that, from the smallness and nearness of the objects looked at, is one requiring great attention on the part of a child. Reading is so universally taught amongst the upper classes, and is in such constant requisition, that many persons hardly recognise the difficulty that a child experiences in learning it, and how important it is that all difficulties should be lessened or avoided.

An adult practised in reading bounds from word to word, and probably sees only a letter here and there, his knowledge of the subject supplying the others and suggesting the meaning of the sentence, while some, as is recorded of Macaulay, appear to take in several lines at a glance; but a child plods laboriously from letter to letter, and to arrive at the end of a single word is a feat accomplished.

The books, then, that should be put into the hands of a young child should have these characteristics:—They should not be too large and heavy. The paper should be clean, white, and smooth. The letters should be large, well-formed, and well printed. The spaces between the letters and between the words and lines should be relatively wide, and the line should not be too long. The light should be good, and, as already stated, should enter from the left side; and, finally, the lessons should not be so long as to exhaust the power of attention. The habit of attention has, like other habits, to be learned, and a few minutes' strain at a time is as much as can be expected from a child of six or seven.

The introduction of good prints into story-books is of advantage, since it both excites the attention and relieves the eye. It would be well if children who have any hereditary tendency to myopia were taught by the long slips, with a picture at the head, sold by most of the large stationers. The child should be placed with his back to the light, and at a distance of four or six feet from the slip. The separate letters and words may be indicated by the teacher with a light wand.

The mode in which writing should be taught is hardly less important than reading. Children are apt to be very slovenly in this respect. They place the copy-book in all sorts of impossible positions—standing, kneeling, or lying; and those who have much to do with examinations know only too well that much of the handwriting of the present day is very irregular and indistinct, occasioning not only loss of time but of temper to decipher it. It is customary to insist that the copy-book should be straight before the child, but no rapid writer ever places his sheet in that position. He sits square to the table, rests the arm well upon it from the elbow downwards, though with a slight elevation of the wrist, the hand being supported on the little finger. The pen is held between the thumb and first and second fingers, pointing well away to the right, and the paper is almost always so placed that the diagonal from the right corner to the left is perpendicular to the edge of the table, and there is no objection to this position being taken up by the child.

The child should be taught to write early. The page should be at fourteen or fifteen inches from the eyes, and should be placed either opposite the right shoulder or diagonally in front. The body and head should be held fairly upright, or with but a moderate inclination forward. The copy-book should be placed on a slightly inclined desk. The page should be well illuminated.

Some children are taught to write by means of a slate, or with lead-pencil and paper, perhaps on the ground that these methods are more cleanly, and that there is less risk of injury to cuffs and collars; but the objections to both plans are that there is a particular reflex, and that the letters are indistinct unless the light falls in a certain direction.

Neither reading nor writing should be permitted in the dim light of evening; nor should a child ever be allowed to read stretched out on the hearthrug, endeavouring—

> "Whilst dying embers through the room
> Teach light to counterfeit a gloom"—

to spell out its lessons. The head is necessarily brought within a few inches of the book, and the strain on the eye, both for accommodation and on account of insufficient light, is very great. The same may be said of reading in bed, which is distinctly hurtful. If the child lies prone, the same objections hold as in lying before the fire; if supine, there is a great tendency to bring the book very close to the eyes, and to make it rest on the chest for support. Considerable strain is also exerted on the inferior rectus muscle, or that one which rotates the eye downward; and this is often complained of by those who read much whilst in the recumbent position.

But girls are taught the art of sewing, and this is certainly more trying to the eyes than any work that boys are called upon to do. In ordinary coarse calico there are about seventy threads to the inch, and what is considered good work in stitching consists in taking up four threads, two in front of the cotton and two behind; but in moderately fine linen—shirt-front, for example—there are about 120 threads to the inch, so that the child has to work to the sixtieth of an inch—a very much smaller distance than the smallest print.

The serious results of lace-work, in which the eyes are severely taxed, compelling nearly all who work at it to use magnifying glasses and leading to premature decay of the eyes and loss of vision, and the impairment of vision complained of by girls who work at night on articles of dress of a black colour, are sufficient evidence of the injurious effects of sewing if too fine or prolonged, or performed under unfavourable condition of light. Hence the sewing required of children, whilst it should be neat and accurate, should not be too fine, nor should too much be exacted of them.

Many children complain that after working for a few minutes the stitches and threads grow dim and indistinct, and that if they still continue to exert the eyes, the stitches run into each other, and a peculiar feeling of dizziness and sometimes of headache, or tension about the brow, is experienced, which disappears as soon as work is given up. In many cases the distress of the child is apparent, for the eyes, after working for half-an-hour, become red and stream with water. In some extreme cases vomiting is actually induced by any prolonged effort to work. In the large majority of these cases the child is long-sighted, and the explanation of the symptoms has already been given.

Ulcer of the Cornea.

The only remaining affection of the eyes in childhood which needs mention here, as being capable of prevention by judicious treatment, is ulcer of the cornea. An ulcer of the cornea commences as a small speck situated on the cornea or glass of the eye, or upon the white. At first, careful examination shows that it is slightly elevated; but in the course of a few days the top separates, the contents of the little pimple are discharged, and a pit or ulcer is left. Much discomfort, if not actual pain, is usually experienced. Light is disagreeable, and the lids are kept closed, or, if forcibly opened, a flood of tears escapes from them. The disease often attacks weak and strumous children, and these may often be seen clinging to their mother, with their heads buried in her lap, or sitting in a dark corner of a room with their hands before their eyes to exclude the light, for hours, almost motionless, during the day; though, when twilight comes, they will sometimes rise to play, and then a casual observer sees in the dim light scarcely anything to indicate that an important disease is in progress in the eye. When an ulcer has formed, medical advice should at once be obtained; and the disease is here only noticed in order to point out that it is often dependent upon injudicious diet.

The children of the poor are constantly brought to the out-patient rooms of hospitals eating unripe fruit or sucking sweets, whilst it is admitted that they have little appetite for wholesome articles of diet. Other pages of this volume are devoted to the consideration of the food that is most appropriate in quantity and quality for children; but if it could be impressed on the minds of the mothers of families, both rich and poor, that bread and milk or porridge for breakfast, meat and potatoes, followed by some farinaceous pudding, for dinner, and bread and milk again for tea, constitute a wholesome diet, and that it is well to abstain from sweets, raw fruit, and pastry, many cases of ulcer of the cornea, which puzzle the medical attendant, irritate the child, and distress the parents, would be prevented or cured.

THE CARE OF THE EYES IN MIDDLE AGE.

The care of the eyes in middle age must depend in great measure upon the occupation that is followed and the means of livelihood. Those who live in a temperate climate, and are engaged in open-air avocations such as farming, or who pursue the ordinary life of an English gentleman, and have healthy eyes to begin with, and who are, withal, moderate in the gratification of their appetites, should be practically free from ophthalmic disease; but there are numerous trades the prosecution of which constitutes a strong predisposing cause to impairment of vision. Many, like those of the tailor, the compositor, and the sempstress, are harmful in consequence of the sustained exertion of the ciliary muscles in effecting the accommodation of the eye for near objects, which they require. Others, like that of the washerwoman, are injurious in consequence of the alternate exposure of the eyes to cold and damp heat. Others, like those of fitters, rivetters, hammermen, and smiths of all kinds, owing to the liability to accident and the effects of bright fires. Others, like farm labourers, harvestmen, and reapers generally, are exposed to cold, and to the singularly dangerous results of a slight scratch of the surface of the eye with an awn of barley or a blade of grass—dangerous because they are usually disregarded, and the man continues to work under a hot sun and drinks largely, whilst he, perhaps, takes little food. Loss of the eye often results in these cases from what might have been originally cured by the instillation of a drop of sweet oil, and the application of a wet pad and bandage, with rest of the eye for a few hours.

It is an interesting fact—showing that the employment of a glass to reveal minute details, even when used in one eye only, is quite harmless—that an examination of a considerable number of watchmakers has shown they have as good, if not somewhat better, average vision than men following other avocations.

There are two agents that in mid-life are largely used, and which deserve attention—tobacco and alcohol.

That tobacco exerts a powerful influence on the nervous system is well known. The first cigar produces a series of effects that are as unpleasant as they are distinctly referable to this action. The burning, bitter taste in the mouth; the augmented flow of saliva; the nausea and vomiting, followed by purging; the giddiness and faintness; the pallor of the face; the outbreak of perspiration on the brow; the feeble and frequent, or slow and feeble, action of the heart, and the utter prostration of the whole muscular system; the depression of the temperature, and, as physiological experiments show, the diminished pressure of the blood in the vessels; and, finally, as has actually occurred when an excessive quantity has been consumed, the fatal effects that may ensue—all betoken the extremely poisonous properties of the drug. A single drop of nicotine applied to the eye of a cat will kill the animal in a few minutes. A small bird will die from the inhalation of a portion of nicotine vapour so small as to be inappreciable by a fine balance. Rabbits, cats, and dogs die in from twenty to thirty seconds with less than a drop placed on the tongue, so rapidly is it absorbed, and so violent are its effects; and man suffers severely with only the 25th of a grain.

No doubt the mode in which it is used—namely, in the form of vapour—materially reduces its poisonous effects; for much of the nicotine is probably destroyed before it is inhaled by the action of the heat of the burning leaves, but some must clearly be absorbed by old sailors and others who chew tobacco.

Habit, however, overcomes this action; the system becomes accommodated to it, and that which was at first detested becomes at length endured, then enjoyed, and ultimately almost indispensable. There are men who would prefer to be blind rather than give up smoking, and it cannot be doubted that it acts in some way or other advantageously in the general economy of the body. The rapid manner in which the habit spreads through a country when once introduced into it—the fact that tobacco-smoking is practised by a very large proportion of the males in the whole of Western Europe and in America, notwithstanding the great variety of race and habits of life—shows that it must possess some beneficial qualities. Its votaries generally extol its soothing and tranquillising effects, especially when the mind is exhausted and irritable, and state that it promotes digestion, and contributes to mental activity.

But even those who are habituated to it can generally perceive the effect of an overdose, or excess, which betrays itself by tremors, unsteadiness in the co-ordinated movements of the hand and eye in actions requiring delicate manipulation, and by wakefulness.

Those who have paid special attention to the process of training for the performance of great feats of physical exertion, such as racing or rowing, consider that good material can be rarely found amongst men who are seriously distressed at the sudden relinquishment of the habit.

It must not be forgotten, however, that the number of cases of impaired vision, which even those who are engaged in ophthalmic practice, and who, therefore, are likely to meet with them, can certainly refer to the action of tobacco, is surprisingly few. Thousands of men smoke many cigars or cigarettes, or pipes, and yet cases of tobacco blindness are so rare that some still doubt its existence. The truth seems to be that it seems to affect the nervous system of some men much more powerfully than that of others; here, as elsewhere, one man may take with impunity what is seriously injurious to another. As a rule, in what is termed tobacco amaurosis, the failure of vision is gradual.

Some intelligent surgeons hold that when tobacco exerts a prejudicial influence on the eyes it is due to some idiosyncrasy on the part of the individual, for it sometimes occurs at an early period of life, when, therefore, the poison has had less time to act injuriously; and it has been noticed that the relatives of such young persons have been liable to exhaustion or wasting of the nerves from other causes.

One of the reasons that render it difficult to mark and distinguish tobacco poisoning is that its excessive use is often associated with other causes of nerve depression, such as the abuse of alcohol, or excessive mental exertion.

The mode in which tobacco is consumed may reasonably be supposed to exert some influence. The active principle is the highly poisonous fluid and volatile alkaloid nicotine. It exists in the leaves in proportions varying from fourteen parts to seventy-nine parts in 1,000—the former quantity existing in the more delicately-flavoured and highly-prized tobaccos of Havannah, the latter in the coarser kinds grown in middle and southern Europe. The composition of nicotine is represented by the formula $N^0H^{14}O^2$.

Probably, the worst method of using tobacco is that of chewing, for even if the saliva be not swallowed a large proportion of the juice must be absorbed. Amongst those who use cigars some inhale the smoke into the lungs, whilst others only allow it to enter the mouth, or mouth and nose.

It has been suggested that one reason why tobacco poisoning is rare, is that more or less alcohol is consumed with it, and that possibly the action of alcohol and tobacco may be antagonistic, so that the poison and the antidote are taken simultaneously.

It is possible that particular kinds of tobacco may exert a prejudicial influence on the nervous system, though it is more probable that the system becomes accustomed to, and can bear, a certain amount of nicotine, whilst if this be materially increased its ill effects are soon experienced. A remarkable case supporting the latter view has been placed on record by Cohn, in which a gentleman, seventy years of age, applied to him on account of rapidly-failing acuteness of vision. The patient was a hale man, the picture of good health, and had been accustomed to smoke from twelve to fifteen Havannah cigars daily from the age of fifteen without experiencing the slightest impairment of his otherwise excellent vision. A few months before applying to M. Cohn, however, he had taken to smoking a kind of Dutch cigar, still consuming from twelve to fifteen daily, and in the course of this period his vision had rapidly failed. In the right eye it was reduced to $\frac{1}{30}$th and in the left eye to $\frac{1}{40}$th of its normal amount. His perception of colours, especially of red and green, was lowered, both tints in small objects appearing yellowish. No changes could be discerned in the eye, after the most careful examination. M. Cohn determined to have the two kinds of cigars analyzed, and accordingly forwarded them to Dr. Poleck, an experienced chemist. At first sight, it appeared that the Havannah cigars, which had been freely smoked for upwards of fifty years, contained a larger quantity of the poisonous agent nicotine than the others, for they contained 2·02 per cent. of nicotine, whilst the Dutch cigars, which he had just commenced to use, and to which he attributed his dimness of vision, contained only 1·8 per cent of nicotine. The enigma was, however, solved by weighing the cigars; and it then appeared that whilst the harmless Havannah cigars weighed 72·5 grains each, the harmful Dutch cigars weighed 139 grains each; so that in smoking an equal number of each kind he inhaled in the case of the Dutch cigars nearly half as much again of nicotine—that is to say, that in smoking twelve Havannah cigars he inhaled 216·5 grains of nicotine, whilst in smoking twelve Dutch cigars he inhaled 300 grains of nicotine. It may be added that, by reducing the allowance of cigars to a minimum and by the administration of appropriate medicines, the vision rapidly underwent improvement, though some dulness of vision, both for objects and colours, remained. Not only, therefore, the number and kind, but the actual weight of the cigars used should be considered.

The use of tobacco is commenced very early in some nations. In "The Voyage of the *Vega*," Captain Nordenskiold states that the Chukches of all ages are great smokers. He often saw little boys leave their mother's breast to take a whiff or two of their father's pipe, and then go back to their mother. The children of the Chukches, like those of the Eskimos, suckle unusually long, generally till they are three years old. The women do not smoke, but confine themselves to chewing tobacco, and this they begin with very early—in fact, before they can walk.

There is reason to believe that in certain sets of men, especially of business men, a quantity of alcohol is consumed which, hard as their work may be, is greatly in excess of what is required, either for nutritive or social purposes. Men who have to undergo severe mental or bodily exertion, can bear a large amount of stimulus with comparatively little harm, though it probably tells even in them. The writer was once crossing the broken country of the Western Highlands, when at a height of about 2,000 feet he was glad to ask for refreshment at a lonely shepherd's hut, the occupant of which, an old man of seventy, was just opening his door. He appeared in a few moments with a large tumbler half filled with whisky. It was declined, on the score that on an empty stomach it would produce intoxication, and that if milk were to be had it would be preferred. The opportunity was too tempting, and the man finished it himself. On inquiry, it appeared that he had already had his breakfast, which had consisted of a basin of porridge, and such another glass, and that his breakfast for many years had included at least this quantity. Yet he was a robust, powerful man, with no other ache, he said, than an occasional attack of rheumatism in winter—perhaps, after more than the usual dose. This man was accustomed to go down daily into the valley, besides, he said, walking about nearly all day tending sheep; and it is reasonable to suppose that the difficult air of the keen mountain-top burnt off the alcohol which he consumed. Health and excellent vision, it is clear, may under such circumstances be maintained.

But the case is different with the dwellers in towns. The quantity taken is at least equal, and the variety probably much greater. Whilst writing this very page, a hale, strong man, the model of an Englishman, thirty-eight years of age, from a large provincial town, called on the writer complaining of great impairment of his vision. He was told that it was of a serious nature—that it was the indication of living too fast, of eating and drinking more than was requisite, and of taking too little exercise. "Exercise!" was the reply. "I take exercise enough; I walk three hours a day hard, from shipper to shipper. I hunt on Saturday, and I take a long walk on Sunday; but I acknowledge I do take more than probably is good for me." He was asked to state what he had taken the day before, and this is the account he gave, word for word:—"I made a good breakfast, though I had been up the night before till half-past two, playing cards. I went down to the City on business, and met two friends, and we had a bottle of champagne; as we finished it another friend joined us, and we had another bottle of champagne. I then had some sherry and bitters, and walked to Cheapside, where I had oysters and half-a-pint of stout. I then took some Kümmel liqueur. In the course of the afternoon I had two glasses of port wine. I dined at seven, and had a pint of claret. After dinner I had one glass of brandy-and-water. But then," he added, "yesterday was a very light day." Such instances of excess are, probably, not rare.

When it is considered how great are the changes in the economy that culminate in the casting off of a bud and the birth of a child; that the bearing of children is in all women a severe strain upon the constitution, as indicated by the debility and exhaustion that are experienced, and by the incapacity to take the usual amount of exercise; by the languor, sickness, and variable appetite; and by a variety of well-known symptoms—it is not to be wondered at that the eyes participate in the general disturbance of the constitution, and that complaint is *frequently* made of more or less impairment of vision. The most common complaint is, that difficulty is felt in reading for more than a few minutes at a time, when the letters begin to run together, and a feeling of giddiness is produced. This sensation is relieved when the book is put down, and when the eyes are closed and rubbed, or strongly pressed. Half a page or more can then again be read, but very soon the same symptoms reappear, and after a few ineffectual attempts the book is thrown down in despair, and fears are entertained that blindness is to be added to other troubles. In such cases black spots, or muscæ, are apt to appear in the field of vision, which produce considerable annoyance, for they constantly attract attention by their movements, which follow those of the eye, whilst they are apt to exactly cover and obscure any minute object that may happen to be looked at. The eyes after a short spell of work not only feel tired and ache, but look red and congested, and the eyelids are apt to adhere in the morning. Objects are not clearly seen, and on waking a distinct effort is required to see print of even large size. Towards evening, and after food, some improvement usually takes place.

These symptoms are often thought to indicate biliousness, and in some instances they, perhaps, really do so; but, as a rule, the patient may take heart of grace and be satisfied that they all are only temporary, and that with returning strength they will wholly pass away. They are, in truth, only indications that the power of accommodation has somewhat failed, that the ciliary muscle is a little weakened, that it requires an unusual nervous impulse to cause the muscle to contract, and that consequently the patient is temporarily made presbyopic.

The affection, perhaps, attracts more notice because it is apt to occur, and is always most strongly marked, in those who are long-sighted, and who have, therefore, enjoyed, as they have thought, particularly clear and good vision, and a little consideration will show why this is so. The long-sighted person, as has been already explained, requires to make a certain exertion—has, that is to say, to accommodate the eyes for distant objects. A very great exertion has to be made to see near objects. Any cause that weakens the tone of the nervous system generally will therefore act much more strongly on the hypermetropic eye than on the normally-formed eye, and will make it difficult and fatiguing for the woman to read or do fine work in proportion to the degree of her long-sightedness. The black specks and flies complained of are in many instances small portions of pigment which are physically detached from the ciliary processes by rubbing the eyes, and after a time break down and disappear. In cases of this kind the patient will find that the use of a low power of convex glass will speedily remove all her discomfort. Symptoms of a character almost identical with those just described are often observed during nursing, and may generally be regarded as indicating that the strength of the system has been overtaxed, and that the child should be weaned. There are some other symptoms, however, which may happen at this period that should immediately lead to careful examination, and which can only be referred to here. Such are sudden loss of vision in one eye, the failure to see one-half of an object, and other forms of distorted vision. These are usually indicative of a blood-vessel giving way either in the globe of the eye or in the brain, and timely and good advice may avert more serious mischief, of which such symptoms are often the forerunners.

THE PRESERVATION OF SIGHT IN OLD AGE.

As age advances various circumstances conspire to impair the vision, and to render it less acute than in childhood and youth. The media of the eye, through which light has to pass before it reaches the retina, and which in young people are exquisitely pellucid, become hazy and dull, and objects are seen, as it were, through a smoky glass. The lens, in particular, loses its limpidity, and becomes, if not cloudy, at least brownish or discoloured; and many may, perhaps, remember the discussion which took place some years ago between Liebreich and Ruskin as to the peculiarities of Turner's painting during the latter years of his life, which were affirmed by Liebreich to be due to Turner's lenses having acquired a yellowish tint. Whether this was so or not in Turner's case, and whether, if present, it would account for the peculiarities of the paintings of his later years, is beside the question, but it is certain that the lens undergoes degenerative changes with advancing years. Moreover, the nutritive processes are less active. The plate of our photographic apparatus is less sensitive. The visual purple of the retina is less freely produced.

The eyes of elderly people, further, require more light to see distinctly than those of young persons, and this seems to be due to two circumstances. First; as we become older the vis inertiæ, or resistance to change of the nervous system, occasioning diminished sensibility, augments; and, secondly, the physical conditions of the eye are less adapted for the reception of images. Old people should read chiefly by day, or obtain good, steady, artificial light by night. The print they read should be clear and of fair size. Foot-notes should be avoided. As a rule, spectacles are required after the age of fifty. Hot rooms, late and heavy meals, are injurious.

The main characteristic of age, so far as the eyes are concerned—that condition which occurs in both sexes, and in all conditions of life—is the recedence of the near point of distinct vision. The printed page, the piece of work, is gradually held further and further away from the eye, or if brought near its close examination is felt to be a strain, and the exertion can only be made for a short time. Remote objects are as distinct as ever, but the outlines of all near objects are blurred and confused. Hence, the letters of a word run into one another, and reading and sewing become difficult or impossible. The eye of the needle becomes doubled or trebled, and workmen in all kinds of handicrafts find that the sharpness of their outlines, whether made with chisel or brush, is inferior to the work of their younger days. Persistent work at near objects is, under these circumstances, distinctly hurtful, and all who after the age of fifty begin to feel that reading at night is attended with difficulty, and is followed by redness and increased secretion of tears and mucus, causing the lids to adhere in the morning, should betake themselves to glasses, which, if appropriately chosen, will really act as preservers of the vision.

But that condition which is the best known, and one of the most frequent causes of impaired vision in old age, is cataract.

The Nature and Prevention of Cataract.

The term cataract is in common parlance often applied to all visible opacities and white spots about the eyes, but properly it is limited to an opacity occupying the area of the pupil, and resulting from a change in the structure and composition of the lens. The lens, so-named from its shape, is the most important of the transparent media of the eye, and is the agent by which the rays proceeding from luminous bodies are brought to a focus on the retina, and by means of which a picture of the outside world is formed on this membrane. Its structure is very remarkable. It is composed of a number of fibres, the edges of which are slightly toothed or serrated, and which interlock with each other in such a way as to form a continuous layer. There are many layers, so that the lens resembles an onion in miniature. In size it is about one-third of an inch in diameter and one-fifth of an inch thick, and it is perfectly transparent, reflecting no light. Hence, on looking into the eye of a child, the pupil seems absolutely black. As age advances, however, the lens becomes less transparent; it reflects yellow rays of light, and one of the causes of the dim and dull aspect of the eyes of old people is that the pupil presents a greyish-yellow appearance, due to the change in character of the lens. Such change, however, is not a cataract; for a patient may still see well, and by a proper arrangement of light, the details of the back of the eye, that is, of parts behind the lens, may be made out with perfect distinctness, proving clearly that it is not opaque or even cloudy.

A cataract consists in the breaking down of the fibres of the lens; these first become finely dotted with fat drops of microscopic size, which, after a time, run together to form larger drops, strongly reflecting light. The fibres then swell in some parts, and in others become attenuated, and at length soften and rupture, so that they can no longer be traced under the microscope; and in their place are fat drops—crystals of a particular kind of fatty body, named cholesterine—and chalky particles. It is to these (if we may so call them) foreign substances, as well as to the altered disposition of the regular layers of the healthy lens, that the white aspect of the lens in cataract is due.

As a rule, cataracts form very slowly, though many instances have been recorded of their complete formation in the course of a few days. That form of cataract which results from injury—as from direct blows on the eye, the penetration of the eye by the point of a needle or knife, or of a pair of scissors, or a thorn—is rapid in its development. It is due to the admission of the aqueous humour to the substance of the lens, and to the swelling up of its tissue. Such cases require immediate and skilled medical and surgical treatment.

But the ordinary form of cataract, which occurs in elderly persons, and hence called senile, is slow in its progress. It usually commences in one eye, which may be so gradually affected as to be unnoticed by the patient until his attention is suddenly awakened to the defect of his vision when on closure of the healthy eye he attempts to look through a telescope with it, or by observing that he is unable to judge accurately of distances—a man often pouring wine over the edge of his glass, and a woman finding it difficult to hit the eye of her needle. The vision is often preserved when the cataract is far advanced and very evident even to unskilled observers, for the changes described above occur in bars and patches, leaving portions of the lens clear and transparent, and through these, as through lattice-work, the patients often see fairly well—quite well enough for all ordinary duties of life; and even on occasion, and with a good light, well enough to read or write. The development of cataract is unaccompanied by pain.

Now and again we meet with elderly people who, after wearing convex or magnifying glasses for many years, are able to give them up, and can even read small print. This phenomenon is generally due to the supervention of cataract, and to some slight swelling of the lens having taken place.

No means, except operation, are at present known by which a cataract, when once fairly formed, can be removed. Medicines, lotions, ointments, electricity, magnetism, are all weapons of quackery and charlatanry; and no experienced ophthalmic surgeon would for a moment encourage the hope in a patient who has well developed, or even incipient, cataract, that it can be conjured away by such means. But inasmuch as it is a progressive disease, and capable of being hastened in its progress by circumstances unfavourable to the general health, so it may be delayed by general care and attention to those rules that may improve the constitution: good food, regular exercise, sound and uninterrupted sleep, a quiet mind, and the avoidance of all work that may strain the eye, would be the best means for delaying, or perhaps temporarily arresting, the progress of cataract. If, however, it still continues to advance, an operation is the only remedy, and this consists in the removal of the lens, or in its solution by the natural fluids of the eye, after the investing capsule has been divided by a needle. The latter method is that usually adopted in children, the former in those occurring at an advanced period of life. The operation itself, though requiring much skill and knowledge, as well as constant practice, on the part of the operator, is not in itself a severe one, and the high interest which attaches to it is dependent on the importance of the issue rather than on any difficulty or danger in its performance.

The Protective Apparatus of the Eye.

The eye, buried as it is in a deep cavity of the skull, and resting upon a soft cushion of fat, is remarkably protected from injury, and it is rare to find it seriously damaged by direct violence, but it is unavoidably exposed to the entrance or lodgment of dust and to the action of irritating vapours; to the sting and bite of insects; and to minor troubles which, though apparently slight, may, by exciting inflammation in the cornea and rendering it opaque, materially impair the visual powers. To prevent accidents of this nature the eye is protected by the eyelids, and by the lachrymal apparatus.

The lids are two processes of skin strengthened by dense tissue termed the tarsal cartilage, which project over the eye, and, by the contraction of a circular muscle, can be made to meet in front of it. Their inner surface, which is soft, moist, and velvety, is accurately adapted to the rounded surface of the globe, and plays over it with extremely slight friction. The upper lid is much the larger as well as the more moveable of the two, and has attached to it a muscle, the elevator of the upper lid, by which it is raised. In sleep the muscle relaxes, and the upper lid falls over the eye, which is thus protected from light. An additional precautionary act takes place in sleep, causing the eyes to roll upwards and inwards, which prevents the entrance of light to the retina through the chink of the lids, and at the same time removes the cornea from the accidental sting of insects. The lids are fringed with a row of large, highly sensitive hairs, which are gently curved in opposite directions—those of the upper lid having their concavity looking upwards, and those of the lower lid downwards. The hairs have been noticed to live for about three months, when they drop out and are replaced by new ones.

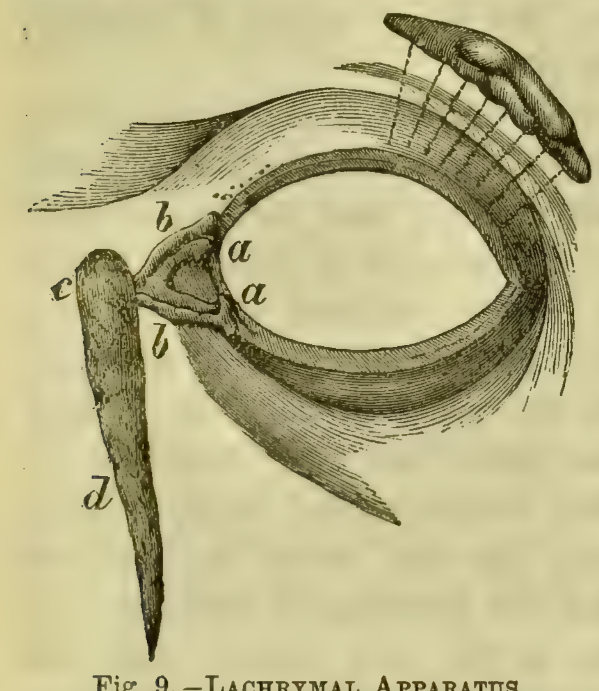


Fig. 9.—Lachrymal Apparatus.

l, lachrymal gland; *aa*, puncta; *bb*, canaliculi; *c*, lachrymal sac; *d*, nasal duct.

Throughout our waking hours the eyelids are in frequent movement, the upper eyelid in particular rapidly descending, and as rapidly rising, whilst the lower advances a little way only, to meet it. This movement fulfils a double purpose: it serves to sweep away particles of dust which have alighted on the surface of the cornea, and at the same time to keep the surface moist and bright.

The lachrymal, or as, perhaps, it ought to be spelt, lacrimal apparatus, consists essentially of a gland *l* (Fig. 9) which occupies the upper and outer part of the orbit, lying between the globe of the eye and the bone. This gland, under the influence of the nervous system, secretes the tears which serve to wash away any foreign body that may have lodged between the lid and the eye. After moistening the surface of the eye the tears are carried away by two small canals, the openings of which, called the puncta lacrimalia, *a a*, may be seen on the edges of the lids, near the inner angle of the eye. These two little ducts unite and discharge their contents into the lachrymal sac, *c*, from which they are conveyed by the nasal duct, *d*, into the nose.

The commonest affections of the eyelids, and the only ones that need mention in treating of the general care and preservation of the eye, are stye, or stine; inflammation of the margins of the lids; twitching or quivering of the lids, and overflow of tears. More serious affections, such as cuts and burns, tumours, drooping of the lids, and eversion or inversion, render recourse to medical advice requisite. A stye on the eyelid is, for its size, one of the most troublesome and disagreeable affections of the body. It produces considerable swelling of the lid, accompanied by throbbing pain preventing sleep; is three or four days or even more in maturing, forms a head containing matter, and then bursts. In a large proportion of cases it is due to errors in diet, though it may occasionally proceed from cold. Sometimes a dozen or twenty follow each other in succession. Their occurrence may be prevented by attention to diet—the avoidance of sweets and of raw fruit and pastry—pure air and active exercise.

Eruptions and inflammatory affections of the margins of the lids often also owe their origin to errors in diet; but if they persist, after care has been taken in this respect, they are often due to the want of appropriate glasses; and examination will show that the child, for such affections are most common in childhood, is long-sighted. If this be the case, other symptoms, already described under the head of long-sightedness, will usually be complained of. Twitching and quivering of the lids are commonly referable to one of two causes—overwork and general exhaustion of the system at large, and long-sightedness. The former condition must be met by rest, better and more abundant food, and freer exercise; the latter by glasses.

In many persons a large tear collects from time to time at the inner corner of the eye, necessitating the use of a handkerchief, or, if this be neglected, rolling down the cheek and causing more or less redness and excoriation of the skin. This condition is due either to the closure, obstruction, or displacement of the puncta lacrimalia, or to some constriction in the lachrymal sac or nasal duct; and may be regarded as a condition of latent disease ready at any moment to burst into severe inflammation. The lachrymal sac is usually distended, forming a smooth, rounded swelling at the inner corner of the eye. This swelling is painless, and on gentle pressure may sometimes be made to disappear, the fluid it contains either running down into the nose or regurgitating through one or both of the small openings of the canaliculi over the surface of the eye. This condition may last for months or years without harm; but at length the distended sac is exposed to some exciting cause of inflammation—such as a slight blow, or the extension of inflammation from the eye or nose, as in ordinary catarrh—and a rather serious disease is quickly established; violent pain is experienced, the swelling increases in size, and becomes exquisitely tender; the eyelids appear puffy and swollen, and occasionally delirium occurs. It is then evident that an abscess has formed, which, in process of time, bursts by one or two small openings. The swelling then subsides; and generally, but not always, the troubles of the patient are over. Occasionally, however, the violence of the inflammation is such that the bone is killed, and much after-trouble results.

It is well, in all cases of watery eye, to attempt to restore the passage ; but for this surgical interference is requisite. If acute inflammation has unfortunately set in, an early opening is advisable, in order that the matter may be allowed to escape before the bone becomes implicated.

The milder cases of overflow of tears that occur in old people are often the result of looseness of the skin of the lower lid, causing the openings of the lachrymal canals to be a little everted, or no longer in contact with the globe of the eye ; and relief may generally be obtained by astringent lotions, and the adoption of such hygienic measures as may promote the circulation and general health of the body.

THE EAR AND HEARING.

By George P. Field.

Aural Surgeon to St. Mary's Hospital.

Anatomy of the Ear—Physiology of Hearing—How we Hear—Disadvantages of Impairment of Hearing—Rules for the Guidance of those who are Partially Deaf—Catching Cold in the Head—Deafness in Children—Injury from Bathing or Diving, and from Artillery Practice—Foreign Bodies in the Ear—Singing in the Ears—Effects of Fevers—Discharges from the Ear—Perforation of the Drum-head—Boxing the Ears—Nervous Deafness—Deaf Mutes—Aids to Hearing.

How is it that we hear? This is a question which, I think, but few persons are able to answer. Whilst the majority of mankind can at least boast with Bottom, the weaver, of "a reasonable good ear in music," and many people not only know what it is to have the teeth set on edge by a grating note, but can detect even minute errors in tone and pitch, yet the structure of the wonderfully beautiful and complex mechanism by which hearing is rendered possible, and the sounds that enchant the ear or the reverse are conveyed to the brain, seems to have been almost by general consent ignored. I shall now, therefore, endeavour, as briefly as possible, to elucidate this mystery.

The auricle, pinna, or outer ear, is essentially a trumpet-shaped expansion of a strong but flexible material, cartilage, by means of which sound-waves are collected together, carried into the ear-passage, and caused to impinge upon the membrane of the tympanum, or drum, of the ear, the consequent vibrations of which, taken up by connecting structures, convey to the brain the impression of sound. A deaf man improves his hearing when he places his hand behind his ear, because he thereby adds to the power of the auricle to take up sound. This power does not, however, appear to be great, since some persons have lost the whole of the auricle without suffering any appreciable impairment of hearing; so we may conclude that, probably, the main use of this outward and visible ear is to indicate the direction whence a sound proceeds.

Wax in the ear prevents the skin from chapping, and, with or without the short thick hairs sometimes found at the entrance of its canal, serves to hinder the entrance of insects or dust.

The Ear Passage, or external auditory canal, is about three-quarters of an inch in length, circular in outline, and hardly large enough to admit the little finger. As it narrows towards its middle, considerable difficulty may be experienced in extracting a pea, or other foreign body, lodged in the cul-de-sac formed by its further end.

The Drum-head, or tympanic membrane (Fig. 1), forms the end of the outer ear-passage, is concave inwards, and slants downwards and forwards. It is composed of three distinct layers, and is very tough and strong, considering its tenuity, which is about equal to that of thin note paper. Were this fact more generally known, people would be less prone to pour strong liquids into the ear, and to pick it with sharp instruments. The truth is, one might almost as well attempt to probe one's eyes with a pin as risk making holes in this very delicate paper-like membranous disc. The old adage, "You should never touch your eye but with your elbow," may well be applied in the case of the ear. The translucency of the drum-head is such that one can see shining through it, running downwards and backwards against its inner side, what is known as the handle of the malleus, or hammer-bone of the ear. The lower part of the smooth surface of the normal and healthy membrane reflects light brightly over a cone-shaped area, the apex of which is opposite the tip of the handle of the malleus.

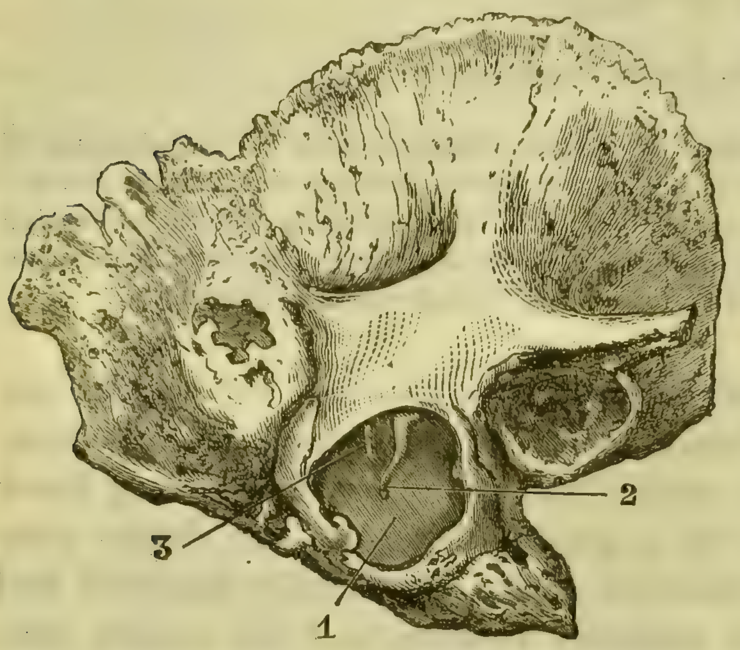


Fig. 1.—Right Temporal Bone. Outer View.

The outer side of the drum-head, with a portion of the ear-bones showing through it.

1. The Membrana tympani, or drum-membrane; 2, the handle of the *malleus*, or hammer-bone; 3, the long process of the *incus*, or anvil. Both bones are seen through the transparent membrane.

Before proceeding further, we must say a few words about the shape of the external ear. Darwin considers the auricle to be rudimentary in man. Certainly the muscles that go to it must be so regarded, for very few persons can move it at will; also, we should add, it has been observed that the more nearly the ear in the brute creation resembles that of man, the less developed are these muscles. One may see in the human ear a small pointed projection from its turned-in margin, or *helix;* this, if enlarged, would form an apex to the ear like that met with in certain of the lower animals; and in some men it does project strangely outwards, requiring only a curl upwards and forwards to make it similar to what one sees in the ancient statues of fabulous sylvan deities. The auricles, especially when small and well set, have for ages been regarded as no mean adornment of the person; and disfigurement by their removal, in which apparently originated the epithet "crop-eared," was in times not far remote a favourite method of punishment. "Me vill cut his ears," says Dr. Caius of his rival; and Prince Henry, hearing Falstaff's slander of himself, cries, "Would not this nave of a wheel have his ears cut off?" Soame Jenyns, writing in 1746, described the politician who—

"Kings, lords, and commons ventures to abuse,
Yet dares to show those ears he ought to lose."

In the middle ages it was not an unusual thing to hang up delinquents by their ears—a practice less endurable but scarcely more deformative than the curious custom, still extant in both savage and civilised society, of loading the ear-lobes with weighty gew-gaws. Fox, in his *Acts and Monuments*,* mentions a singular use of the auricle, relating that the "Tartarians," after having vanquished the army of Henry, prince of Polonia and Silesia, "recounting their victory, by taking each man but one ear of every one of the Christians that were slain, found the slaughter so great, as that they filled nine great sacks full of ears." Lavater, the physiognomist, professed to judge of character by the nature of a man's ears; and another French author went so far as to say, "Montre moi ton oreille, je te dirai qui tu es, d'où tu viens, et où tu vas"—*i.e.*, "Do but show me your ear, and I will tell you who you are, whence you come, and whither you are going." Dr. Laycock held that the shape of the ear afforded a clue to the original development of the brain, and that its appearance was indicative of the condition of structures within the skull; but, as Mr. Jonathan Hutchinson points out, we can hardly follow him so far as to believe that a special state of the ear is associated with general paralysis, and that the adhesion of the lobule to the cheek from birth—which, indeed might be purely hereditary in origin—bears upon the occurrence of that disease. We cannot, however, but accept the conclusion of the latter distinguished observer, that "the ear affords excellent facilities for observation as to the general state of nutrition and circulation," and that "the degree of perfection in its form is a tolerably safe guide as to the descent of the individual from a sound and well-bred stock."

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* Vol. I., p. 385, 9th Ed., 1684.

The Middle Ear, drum, or tympanum (Fig. 2), is a small air-chamber, with hard bony surroundings, ventilated internally from the throat by an air-passage, called the Eustachian tube, and closed in externally by the drum-head, or tympanic membrane, just described, between which and the complicated structures of the internal ear it consequently lies. In front of this chamber, separated from it merely by thin bone, a highly important blood-vessel, the internal carotid artery, runs up towards the interior of the skull.

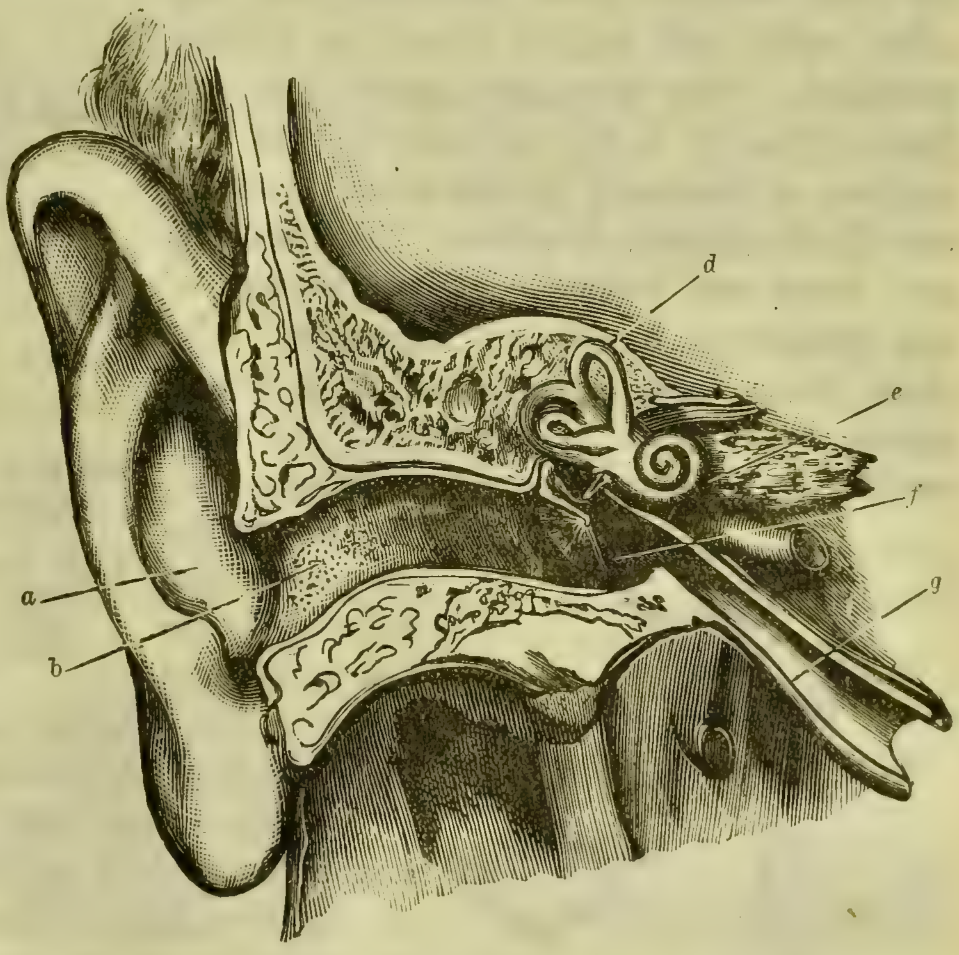


Fig. 2.—TRANSVERSE SECTION OF THE EAR. RIGHT SIDE.

a, External ear-passage; *b*, cerumen glands; *c*, brain; *d*, semicircular canals; *e*, cochlea; *f*, drum, or tympanum; *g*, Eustachian tube.

Lining the hollow of the drum, and forming the innermost layer of the drum-head, is a delicate mucous membrane, like that inside the mouth; it envelops the little chain of bones within the drum, and, passing forwards and inwards, coats the interior of the Eustachian tube.

About an inch and a half long, the Eustachian tube passes forwards and inwards from the anterior part of the drum cavity to the throat behind the nostrils. The atmospheric pressure required on the inner side of the drum-head to counterbalance that on its outer side is provided for by the communication of the Eustachian tube with the throat by its inner end in the acts of breathing and swallowing. If the tube is healthy, a little click may be heard as one swallows, owing to the entry of air into the drum. When, through a cold or disease, the tube remains closed, and the air in the drum becomes rarified, the drum-head and the little chain of bones connected therewith are forced inwards, and, by causing excess of pressure on the structures of the internal ear, produce deafness. Loss of hearing is far more common from this than from any other cause, and can, as a rule, be quickly remedied. The tympanic ossicles, or ear-bones (Figs. 3, 4, 5), are named : (1) The malleus, or hammer ; (2) the incus, or anvil ; and (3) the stapes, or stirrup. The malleus and incus are suspended from the roof of the tympanum by delicate ligaments. The three bones form a chain, which is swung across the chamber of the drum. By their oscillations they transmit vibrations of sound, received by the parchment-like drum-head, to the fluid contained in the internal ear, a portion of the acoustic apparatus presently to be described.

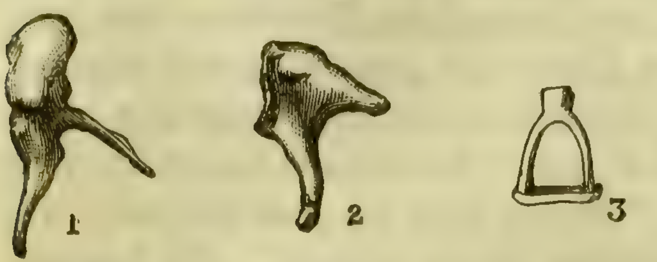


Fig. 3.—THE OSSICLES, OR EAR-BONES, ENLARGED.

1, *Malleus* or hammer; 2, *incus* or anvil; 3, *stapes* or stirrup.

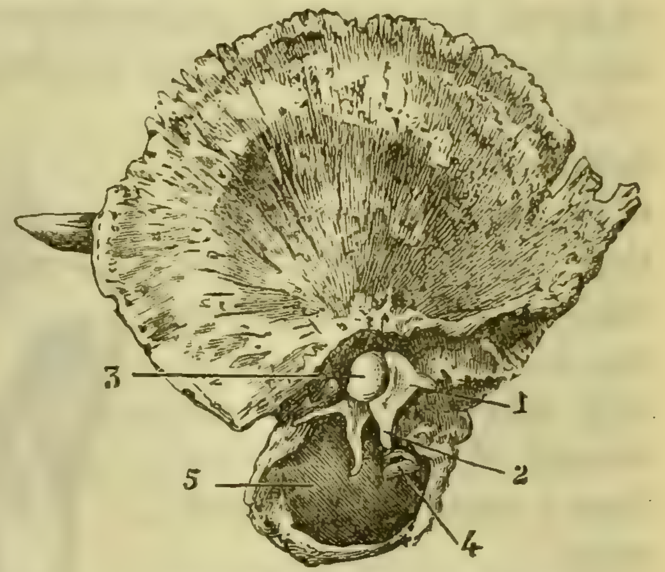


Fig. 4.—A CHILD'S RIGHT TEMPORAL BONE, FROM WITHIN, SHOWING THE INNER SIDE OF THE DRUM-HEAD, WITH EAR-BONES IN POSITION.

1, The *incus*, or anvil; 2, the long arm of the anvil; 3, the *malleus*, or hammer; 4, the *stapes*, or stirrup; 5, the drum-head, or *membrana tympani*.

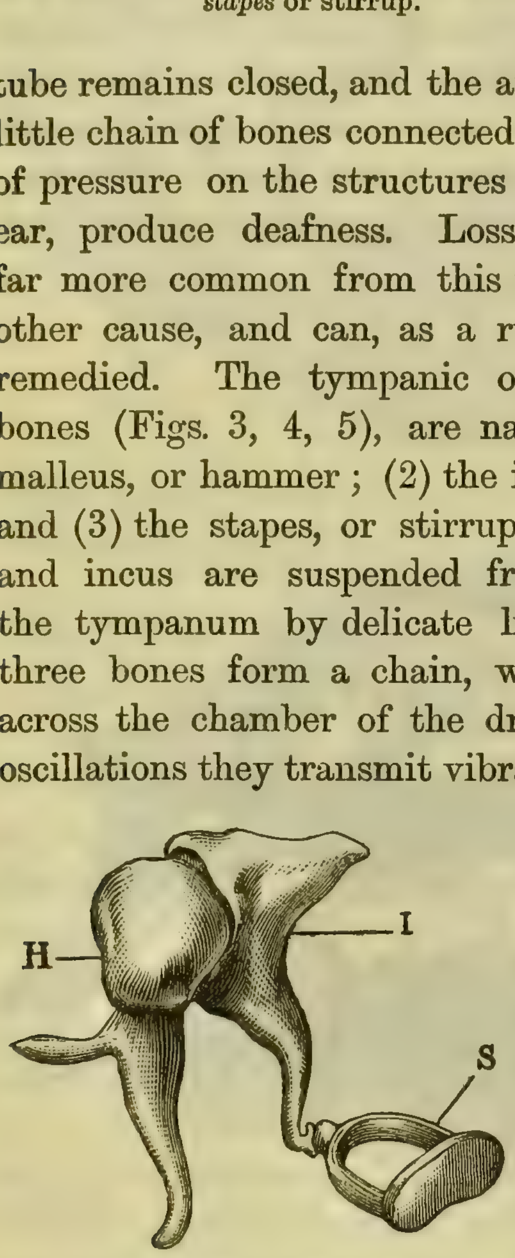


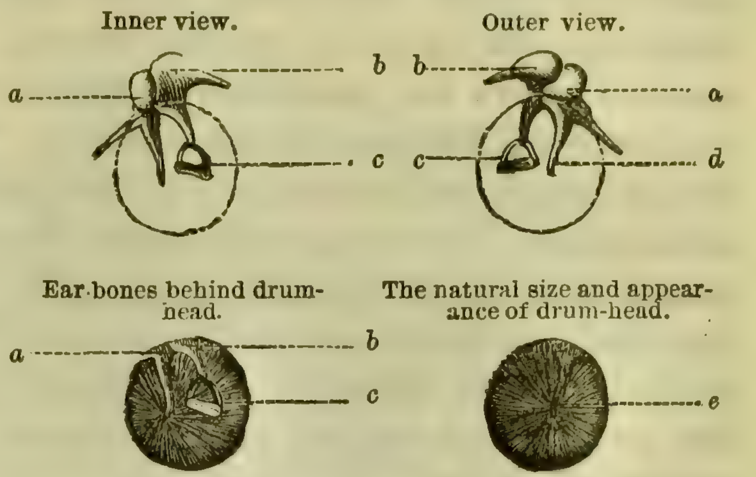
Fig. 5.—EAR-BONES, SEEN FROM THE FRONT.

H, *Malleus*, or hammer; I, *incus*, or anvil; S, *stapes*, or stirrup. Enlarged four diameters.

We have seen that the handle of the hammer at the one end of the chain of ossicles is attached to the drum-head. The foot-plate of the stirrup at the other end of the chain is similarly attached to a membrane (Fig. 6). This second membrane closes in a small oval opening, or window (*fenestra ovalis*), in the inner wall of the drum, separating its cavity in part from another space, called the vestibule, in which are lodged fluid-containing structures belonging to the internal ear. When we observe how the hammer and the stirrup are connected together by the anvil, it becomes evident that oscillations to and fro of the first named, in consequence of vibrations of the drum-head, must cause similar motions of the foot-plate of the stirrup and its attached membrane ; these affect the fluids and eventually the nerve-fibres of the internal ear, thus producing the sensation of hearing. The extent of the vibrations of the two membranes above mentioned is limited by two muscles—namely, the *stapedius*, going from the floor of the drum to the point of junction of the stapes and incus, and the *tensor tympani*, going from the drum-wall to the malleus.

It has been estimated that the oscillatory or piston-like movements of the stapes in the production of some high notes exceed 40,000 per second, and for some low notes are only 16 per second.

We must now give some description of the internal ear. This consists essentially of membranous structures, containing and more or less surrounded by fluid, and lodged in and corresponding in name to three bony chambers—the *cochlea* in front, the *semicircular canals* behind, and the *vestibule* between and communicating with both of them. The semicircular canals are tubular, and like horse-shoes in shape; they lie at right angles to each other, just as do three adjoining sides of a box, and open at their ends into the back of the vestibule by five apertures, the superior and posterior canals having two ends conjoined in one.



Inner view. Outer view.

Ear-bones behind drum-head. The natural size and appearance of drum-head.

Fig. 6.—The Drum-head, or Membrane. Right Side.

a, Hammer; *b*, anvil; *c*, stirrup, which is attached to fenestra ovalis; *d*, handle of hammer; *e*, handle of hammer, seen through membrane. In the two upper figures a dotted line indicates the position of the drum-head, or membrane. In the two lower ones, the drum-head is drawn with the portions of bones actually seen in the space covered by the membrane.

We can venture to recommend a more than cursory perusal of the following description of the minute structure of the internal ear only to those who are sufficiently stout of heart not to be taken aback by complicated details.

The bony cochlea, so called because when freed from the less dense surrounding bone it is like a snail-shell, has its broad end against the bottom of the internal auditory canal. For a view of its relations to neighbouring bony structures, see Fig. 7.

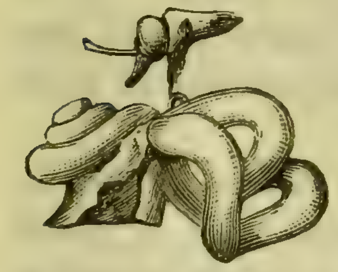


Fig. 7.—Right Osseous Vestibule, Semicircular Canals, Cochlea, and Ear-bones.

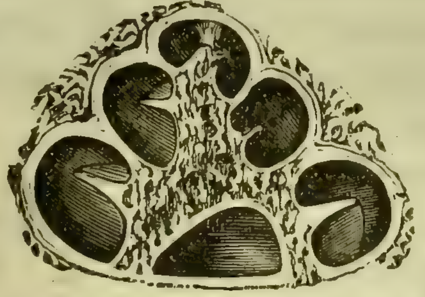


Fig. 8.—Cochlea in Section, showing Modiolus. Magnified.

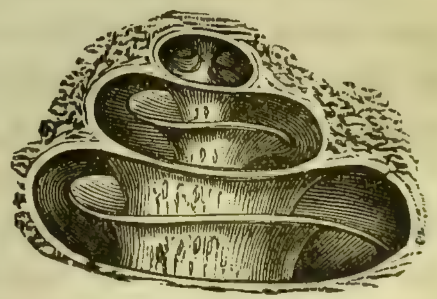


Fig. 9.—Cochlea laid open to show Lamina Spiralis. Magnified.

The cavity of the cochlea, gradually diminishing, takes two and a half turns round a central tapering axis, called the *modiolus* (Fig. 8).

From the modiolus there extends into the cavity, growing narrower out of proportion to the size of the same as it ascends, a bony spiral lamina—the *lamina spiralis* (Fig. 9).

This is continued outwards into a membranous plate, the *basilar membrane*, which completes the division of the cavity into two chambers. The chamber which is uppermost when the cochlea is regarded with the base downwards is separated into two by another membranous plate, running obliquely from the wall to near the end of the spiral lamina, and known as the *membrane of Reissner.* The chamber below the basilar membrane, called the *scala tympani*, would, but for the thin diaphragm closing in the fenestra rotunda, communicate with the tympanum. The chamber above the membrane of Reissner, the *scala vestibuli*, has an opening into the lower and fore part of the vestibule. These two scalæ contain a watery fluid, the *perilymph*, and at the apex of the cochlea are united by a minute aperture, the *helicotrema.* The triangularly-shaped chamber comprised between them, called the *duct* or *canal of the cochlea*, or the *scala media*, contains a fluid, the *endolymph*, like that just mentioned, and by a small membranous canal (*canalis reuniens*) near its larger blind extremity opens almost at a right angle into the smaller of the two membranous sacs which are suspended in the perilymph of the bony vestibule, namely, the *saccule.*

Within the cavity of the cochlear duct, and bathed therefore by endolymph, several different structures have been observed, of which the most peculiar, and doubtless by far the most important, is that which we are about to describe—namely, *the organ of Corti.*

The individual cells of human beings, just as whole organs, evidence a capacity for alteration in their structure to fit them for the performance of special functions.

The organ of Corti consists really of cells, peculiarly modified, belonging to the inner lining, or epithelium, of the basilar membrane.

Passing from without inwards we find, first, what are termed the *supporting cells of Hensen;* these over-ride rows of cells which, their free ends being clothed with stiff cilia, are distinguished as the *outer hair-cells.*

Next, more internally, we come upon the *arch of Corti*, which is made up of two rows of pillar-like cells inclined towards each other, like cards placed face to face so as to support each other, and making an angle at the junction of their upper thickened portions, or heads.

The convex head of each outer pillar is received by a concave surface formed by the heads of two inner pillars. Over the space covered by the arch of Corti the substance of the feet of the pillars is interblended. The inner pillars support a row of large cells, the *inner hair-cells of Deiters;* and still further inwards is seen a single layer of columnar supporting cells. A very delicate structure, Kölliker's *lamina reticularis*, the limits of the outer and inner divisions of which are the two sets of supporting cells above mentioned, is pierced by small rimmed openings, like eyelet-holes, through which protrude the ciliated ends of the outer and inner hair-cells. The portions of the lamina reticularis lying between these holes, and resembling fingers in outline, are known as the *phalanges of Deiters.*

Minute nerve-fibres are distributed to the pointed ends of the inner hair-cells; and still finer filaments pass between the bodies of the pillars of Corti's arch to end in the outer hair-cells. The nervous network supplying the organ of Corti passes into a layer of ganglionic tissue, the *ganglion spirale Corti,* similar in its essential structure to those nodular highly complex masses, or ganglia, which are to be found in certain situations in the course of many nerves, and which serve, apparently, the purposes of a sort of agency offices for the reception, interpretation, and furthering of messages.

The ganglionic layer, again, is connected with branches of the cochlear nerve, which lie in canals in the modiolus.

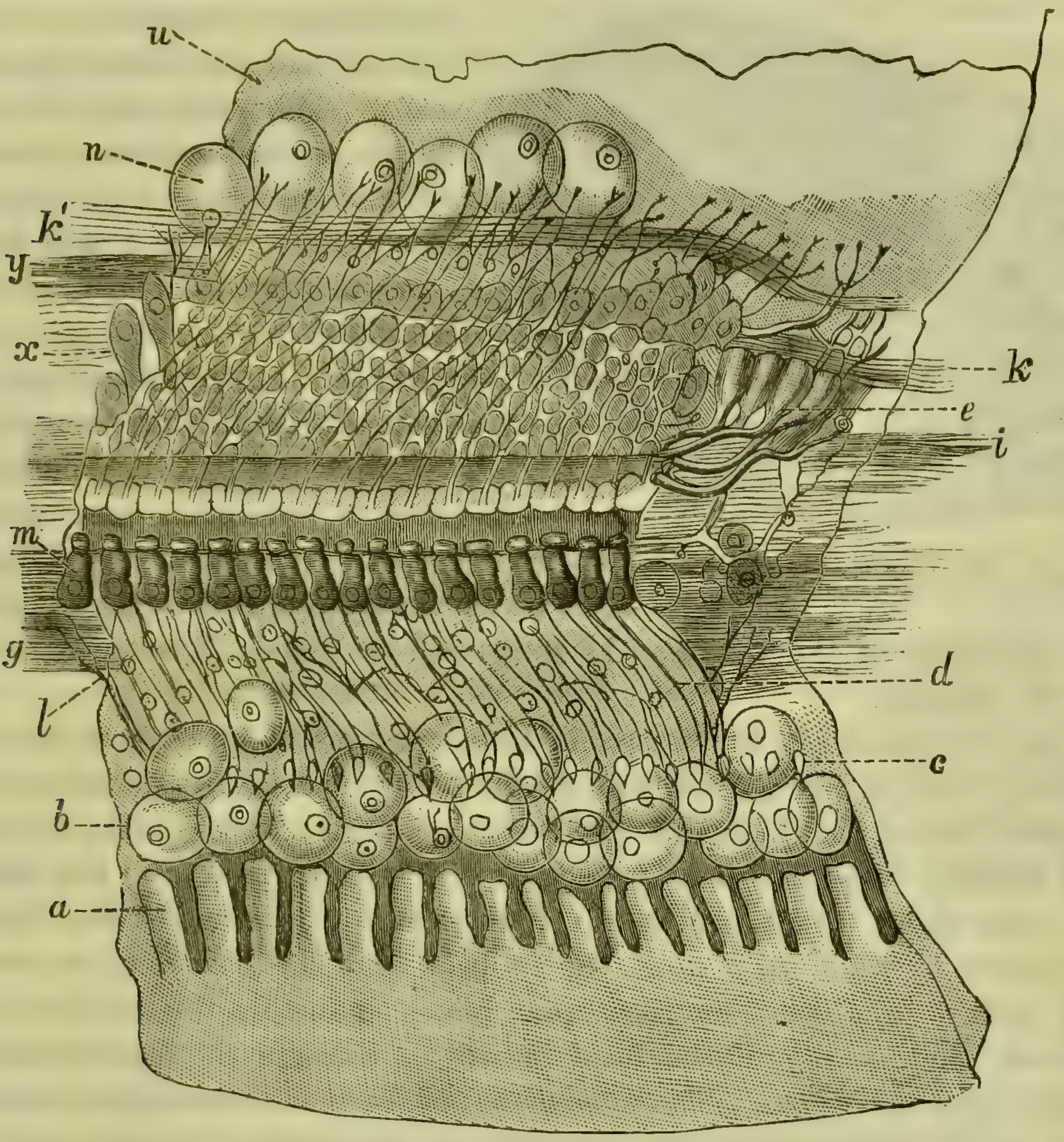


Fig. 10.—Terminal Auditory Apparatus.

The entire Membrana Basilaris, with all its parts lying exposed from above to show the proportion of nerves. Corti's organ from the side.

a, The auditory teeth; *b*, the cells lining the sulcus spiralis; *c*, the holes of the habenula perforata for the passage of the nerve-fibres of the organ of Corti; *d*, the inner rods, or pillars, of Corti's arch; *e*, the outer pillars of Corti's arch; *g*, inner spiral nerve-fibres; *i*, *k*, and *k'*, outer spiral nerve-fibres; *l*, ascending nerve-fibres; *m*, the inner hair-cells; *n*, the cells of Claudius, lining the outer angle of the scala media; *u*, the external portion of the membrana basilaris; *x*, the cells of Corti: to the right of these, and covering them, is seen the lamina reticularis with its phalanges; the outer hair-cells are also indicated; *y*, the outer supporting cells of Hensen.

A very small canal from the saccule, the less capacious of the vestibular membranous sacs, or vesicles, joins a similar canal from the other sac, the *utricle* (Fig. 11), so that the endolymph of the two is in communication. Attached over a portion of the inner wall of each sac, called the *macula acustica,* where several branchlets of the vestibular division of the nerve of hearing are distributed, are groups of numerous minute particles of carbonate of calcium, resembling crystals, and termed *otoliths* (literally, ear-stones), or *otoconia* (Fig. 11). The membranous semicircular canals may be regarded as tubular prolongations of the saccule. Their swollen bases, or ampullæ, receive numerous twigs from the vestibular nerve, which enter them where they are connected to the bone around. At this point there projects into the endolymph a small rounded protuberance, the *crista acustica.* This, like the macula acustica, has an epithelium consisting of superficial cylindrical or conical cells and deeper spindle-shaped cells. The outer end of each of the latter sends up among the superficial cells a process which terminates in the endolymph as a stiff rod or hair; the inner end is connected with a network of fine nerve-fibrils. It is said that the semicircular canals have the important function of maintaining our equilibrium, but this question is perhaps beyond our present scope.

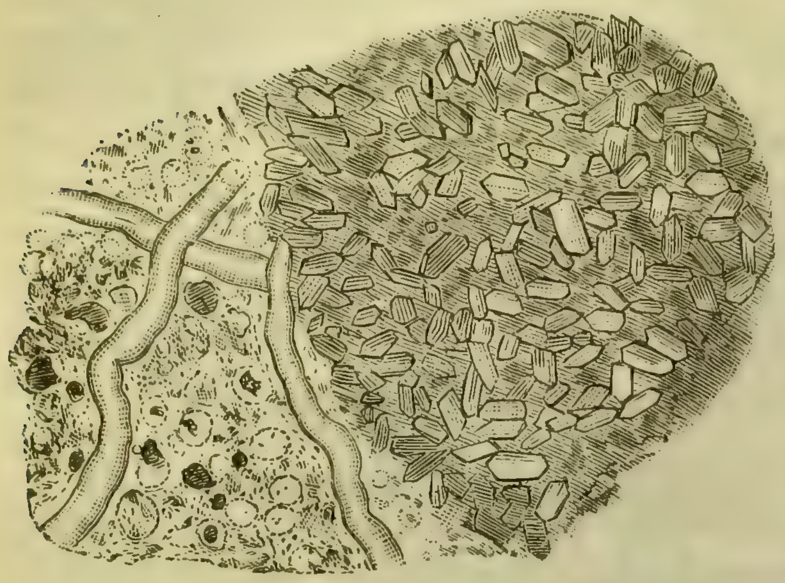


Fig. 11.—Wall of Utricle, with Otoliths.

We have now to consider how the above-described various parts of the sensory apparatus of the ear may be supposed to furnish their possessor with the capacity of hearing.

Happily for mankind, the tympanic membrane emits no note of its own when it vibrates; were it not so, the roll of the little ear-drum would mingle with and modify every sound that is heard. As we have already had occasion to observe, the sense of hearing depends upon the occurrence of disturbances in the fluids of the internal ear; these, there can be no doubt, cause excitation of the fibres of the auditory nerve by their effect upon the otoliths and the hair-like processes of the auditory cells. The tympanic membrane forces to and fro the attached handle of the malleus, the rocking of the head of which, through the intermediation of the incus, acts upon the stapes. The movements of the membrane of the fenestra ovalis, by reason of the excursions of the foot-plate of the stapes, produce movements of the membrane of the fenestra rotunda corresponding in character, but reversed in direction. This results from the fact that the perilymph of the vestibule, which is directly agitated by every vibration of the membrane of the fenestra ovalis, is in immediate communication with that of the conjoined scala vestibuli and scala tympani of the cochlea, the latter of which is closed in at its larger end by the membrane of the fenestra rotunda. It is interesting to note that oscillations in the perilymph of the scala vestibuli must travel through the whole length of that canal—that is, to the apex of the spire of the cochlea—before they can be directly transferred to the perilymph of the scala tympani, just as in a coal-mine—to compare great things with small—the descending current of air, in consequence of the careful blockage of all lateral ways of communication, must pass to the extremity of the workings before it can become the ascending or return current. The endolymph occupying the scala media, or duct of the cochlea, is thus very fully exposed to the influence of disturbances in the perilymph round about it.

From its close relation to the chambers of the internal ear, one perceives that the most important of the auditory ossicles must necessarily be the stapes. The sense of hearing has been known to persist when, in clumsy attempts to extract foreign bodies from the ear, the two other ossicles have been removed, or when they have been set free and carried away by the discharge of a tympanic abscess. One finds also that in cases where, in consequence of disease, the stapes has become fixed in position, or its dislodgment has allowed of the escape of the perilymph, the patients suffer from permanent deafness. In instances where the stapes has lost its mobility, but the fluids of the internal ear are retained, some degree of hearing may, however, still be possible, vibrations of sound being conveyed to the auditory nerve through the bones and other tissues of the head. As one often has cause to note in medical practice, auditory phenomena may be produced simply by the influence on the nerve of unhealthy conditions of the ear, either alone or in conjunction with disorders of other structures of the body.

The proper perception of sound seems to be effected by a division of labour among the various parts of the ear. In some of the lower animals, what represents the membranous vestibule in man is the sole organ of hearing; hence we may conclude that this is the most essential portion of the auditory apparatus. Its nerves are supposed to enable us to judge only as to the intensity or quantity of sound, and those of the semicircular canals as to its direction; whereas the special function of the organ of Corti is apparently to enable us to discriminate between sounds—*i.e.*, to judge of their quality. Hence, if these theories are correct, it is the semicircular canals that, when we desire to study, apprise us of the existence of a hurdy-gurdy immediately below our window; while the vestibule affords us the information that the sounds are overpoweringly noisy, and the organ of Corti keeps us constantly aware that the instrument is out of tune—

> "Straining harsh discords, and unpleasing sharps."

It has been suggested that each of the little arches of the organ of Corti with its accompanying nerve filament is comparable to one of the keys of a piano with its corresponding wire, and that the two answer to their proper note just as an untouched harp-string responds in unisonant vibration to a voice singing the special note which it is itself capable of emitting when struck. According to this idea, the organ of Corti must far surpass in selective capacity the skilled lace-maker who, from two or three hundred bobbins, can select the one which she requires at any particular moment; for it has been estimated that the arches in a single scala media number some three thousand.

With respect to the arches of Corti, we must bear in mind that, since they are not elastic and vibratile structures, and since, moreover, birds—creatures apparently well able to distinguish diversities of tone—do not possess them, they may subserve but the single purpose of supporting the hair-cells. It has been thought that the hair-cells are affected by various sounds much as the hairs on the antennæ of a species of *Mysis*, a minute crustacean, which were observed by Hensen to vibrate some to one note and some to other notes of a keyed horn. It has been surmised that the appreciation of dissimilarities in the rate of vibration in the hair-cells may depend upon the degree with which different segments of the membrana basilaris are stretched.

But we must now leave a confessedly abstruse subject, and pass on to other considerations in regard to the reception of sound—that agent without which the internal ear, with all its wonderful mechanism, would in man and beast alike be no more than one of nature's articles of *vertu*.

The sensation of sound is dependent on a molecular disturbance, or a kind of motion of certain special constituents, of the auditory nerve; consequently, it is not of necessity dependent upon influences external to the hearer; and, as we have seen, it is sometimes produced simply by abnormal bodily conditions. Usually, however, it is the result of a shock, or series of shocks, communicated through the medium of the atmosphere to the tympanic membrane. It would appear that in most, if not in all cases where sound seems to be conveyed directly to the auditory nerve through the structures of the head, air serves for its transmission; for the vibrations of a tuning-fork placed on the head which have ceased to be heard by an open ear may still be perceived by one that is covered externally, so as to afford a closed cavity outside the tympanic membrane in which the vibrations may be amplified by reverberation.

The normal ear apparently best hears sounds that are produced by about 3,000 vibrations a second. Usually, high tones are more audible than low tones equal to them in intensity; hence, probably, it is that deaf people hear shrill better than grave notes, and the voices of women and children more easily than those of men. Helmholtz has pointed out that the vibrations of the membrana tympani are diminished in extent by $\frac{2}{3}$, and thus inversely strengthened, by virtue of their transmission by means of the auditory ossicles. A sound is not perceptible for more than a very short time after its cause has ceased to operate, because the excursions of the tympanic membrane are hampered by the handle of the malleus. When tense, the tympanic membrane responds best to sounds of high rates of vibration; when relaxed, to sounds of low rates. Dr. W. H. Wollaston found * that the ear became insensible to grave sounds when, by shutting the mouth and nose and making a forcible attempt to take a breath, so as to partially exhaust the air in the tympanum, the membrane was made tense. To be heard at all, it is evident that vibrations require to be of a certain amplitude and duration; and it has been proved that, to produce the impression of a continuous musical note, they must be at the rate of not less than thirty (some say sixteen), and not more than 35,000 (or, possibly, 38,000) per second. Vibrations slower that 30 per second are heard separately, and vibrations above 35,000 per second are not heard at all, these numbers being respectively the limits of what are known as tones of low and tones of high pitch. Ordinary musical tones range between 40 and 4,000 vibrations a second. Skilled musicians, it is said, may be able to perceive a difference between two notes of as little as 1-64th of a semitone. Sounds that are irregular in duration, strength, or time of emission, or that are inharmoniously blended, are heard as noise. The capacity of the ear to take cognizance of several distinct vibratory impulses at the same time constitutes one of the chief sources of enjoyment in the hearing of music, since it is the extra tones—or overtones, as they are termed—whose vibrations are in the ratio of simple multiples of those of a fundamental note, that give to the latter its quality, richness, or timbre.

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* "Philosophical Transactions," Vol. XC.

Although the majority of persons are capable of hearing about nine octaves of notes, there are some whose audition is restricted to far less. Wollaston discovered that the power of hearing ceased in a friend of his at a note four octaves above the middle E of the pianoforte, although his perception of musical pitch was as correct as that of ordinary ears. As Wollaston was, perhaps, the first to point out, the chirping of the cricket, the squeak of the bat, and the peeping of the common house-sparrow are of too high a pitch to be heard by some. "The suddenness of the transition," says he, "from perfect hearing to total want of perception occasions a degree of surprise, which renders an experiment on this subject with a series of small pipes among several persons rather amusing. It is curious to observe the change of feeling manifested by various individuals of the party in succession as the sounds approach and pass the limits of their hearing. Those who enjoy a temporary triumph are often compelled in their turn to acknowledge to how short a distance their little superiority extends." He further makes the interesting remark that "since there is nothing in the constitution of the atmosphere to prevent the existence of vibrations incomparably more frequent than any of which we are conscious, we may imagine that animals like the grylli, whose powers appear to commence nearly where ours terminate, may have the faculty of hearing still sharper sounds, which at present we do not know to exist, and that there may be other insects hearing nothing in common with us, but endowed with a power of exciting, and a sense that perceives vibrations of the same nature indeed as those which constitute our ordinary sounds, but so remote that the animals who perceive them may be said to possess another sense, agreeing with our own solely in the medium by which they are excited, and possibly wholly unaffected by those slower vibrations of which we are sensible."

Many of us, it is to be feared, acknowledge to ourselves, even if we are loath openly to confess, that a deaf person is what is commonly called a bore. Of some worthy creature in whose company we have, perchance, had to pass an evening, our sole reminiscence is, to use the words of Chaucer, that—

> "She was som del defe, and that was scathe."

Certainly, the constant necessity of rehearsing in a loud voice what has been said in conversation, however trivial, in reply to the oft-repeated query, "What is it?" or "What did he say?" is not only apt to be wearisome, but may become positively trying to the temper, especially when, as is quite within the bounds of possibility, one's communication is not gratefully received, or is incomprehensible to the listener, because he has lost the pith of the story or the point of the joke to which one would refer. It assuredly is somewhat tedious—to mention no imaginary case—to hear the deaf son tamely repeat, at one end of a dinner table, the tale which he has failed to perceive that his father has just been telling at the other end. There is no denying that in a thousand ways, many of which must have already suggested themselves to my readers, deafness is, both to a man affected with it and to his friends, a dire calamity. The contentment and unaccountable vivacity of the blind have often been commented on, and have been contrasted, not unduly we must admit, with the very generally cheerless and melancholy demeanour of the deaf. One would, on first thoughts, imagine the everlasting absence of the pleasures of vision to be as great a misfortune as the loss of the singing of birds, the voice of friends, the strains of music, and other sounds delightful to the ear. When, however, we come to perceive how deafness, out of all proportion to blindness, shuts men off from intercourse with the world of living men around them, we are no longer at a loss to comprehend the dulness and dejection so frequently seen in those that suffer from it. Kitto goes so far as to say that "it is surely a social duty in the deaf to avoid company." The blind but hearing infant, having its intellectual capacity fostered by facility of interchange of thought, early begins to make progress in mental development; but the child that has either been born or has become deaf is, in ordinary circumstances, debarred from the influence of this potent educational stimulus, and all methods of instruction are shackled by the stupendous initial difficulties of adapting them to the perceptions of the sufferer.

Dean Swift but faintly depicted the destitution of many a deaf man when, sketching his own condition, he wrote the characteristic lines :—

"Deaf, giddy, helpless, left alone,
To all my friends a burden grown;
No more I hear my church's bell,
Than if it rang out for my knell:
At thunder now no more I start,
Than at the rumbling of a cart:
Nay, what's incredible, alack!
I hardly hear a woman's clack."

Let us attempt for a few moments to realise some of the annoyances and trials that must daily be endured by the deaf in ordinary life. If so be our deafness is complete or is severe, no friendly knock can awaken us in the morning; the breakfast-table is silent as the grave; and we walk out among men seemingly as among speechless mummers. When we cross the road, no warning voice can apprise us of danger; and if we enter a shop, the answers to our inquiries must be written down for us, or made comprehensible by signs. Churches and theatres are alike practically closed, music is no more, and the visits of friends are few and far between. He that is poor and, though not absolutely deaf, has become hard of hearing may fail of obtaining fit employment, and increasing want and finally the workhouse are his assured heritage. Often have I asked in our Unions the reason for the presence there of some apparently able-bodied and comparatively young-looking person, and well-nigh invariably have I received the answer, "Oh! he is very deaf, and could never get anything to do." Such are the servants who for deafness have lost their places, and who can find none to help them, and also many an incurable hospital out-patient who struggles on, from day to day growing more shabby and cadaverous in appearance, hoping to avoid the poor-house, but "through weakness . . . forced at last to yield himself unto the mighty ill."

Having now considered (1) how we hear, and (2) some of the disadvantages of impairment of hearing, let us proceed to discuss the best methods of preserving the powers of the ear, and then lay down some general rules for the guidance of those that are partially or wholly deaf.

The necessity of shunning the causes which tend to injure the mechanism of the ear and, more especially, to diminish the efficiency of the auditory nerve is a matter which unfortunately those whose hearing has never been defective but seldom dwell on. Of these causes the chief is exposure to chills and to the shocks of loud sounds.

A most essential thing for the avoidance of deafness is to run no risk of catching cold in the head—perhaps its most common source. Although the variable climate of England has much to do with this complaint, still, in a great majority of instances, carelessness and lack of common sense are far more accountable for it. Thus, some persons go about either over or underclad: a lady in the middle of a mild winter's day, for example, hurries hither and thither oppressively warm in her thick sealskin jacket; but at night, when a frost has just set in, she attends a ball in a low muslin dress. What wonder that severe cold and sore throat result! Again, cold in the head, the precursor of ear-disease, is often due to reckless sitting or standing in draughts. A man, after heating himself in running to catch a train, elects to grow cool by travelling with his face towards the full current of air from an open window, and very soon, in consequence, his friends have to commiserate with him upon a stiff neck or earache. Other and similar sources of danger to the ear are exposure to wet, damp feet, neglect to change the clothes after excessive perspiration, and cutting the hair too short, or washing it at bed-time. The ear is much more liable to be affected by a succession of slight attacks of cold than by a single severe one. What are the several pathological processes involved in taking cold, it would be beside our purpose here to discuss in detail. Suffice it to say that the vessels supplying the mucous membrane from the nose to the mouth expand, and the blood within them flows slowly or stagnates—that is, the mucous membrane becomes congested. As a result, there is more or less swelling, with augmentation of the natural secretions. The congestion is apt to be continued into the mucous membrane of the Eustachian tube, and thence it may spread to that of the tympanum. By degrees, as one cold after another is caught, the mucous membrane becomes permanently thickened, and the functions of other structures, notably the little ear-bones, are interfered with. When, by the thickening of the walls of the Eustachian tube, the passage of the air through it to the drum is blocked, the tympanic membrane soon gets to be unduly pushed inwards by atmospheric pressure; and we have already seen how important it is for the integrity of the hearing that the membrane be free to vibrate naturally. Some little space has above been devoted to the subject of cold-catching, firstly, because aural disease, particularly aural catarrh, due thereto, is very common, and, secondly, because although generally amenable to treatment when early attended to, yet, if neglected, it induces deafness of a usually most severe and intractable character. Aural catarrh is not necessarily preceded by affection of the throat or Eustachian tube, as it may begin primarily in the tympanum, and then deafness very rapidly comes on. As a rule, catarrhal deafness is a malady of slow production, especially during its earlier stages. The hearing-distance gradually diminishes, only an inch or so being lost in a twelvemonth. The sufferer's friends are for long scarcely conscious of the change going on; but at length they pronounce the verdict that he is becoming very inattentive and dull of apprehension, and if he happen to belong to that class of mortals whose brain-development is popularly imagined to be promoted by appeals to brute force — *i.e.*, children—his so-called absence of mind and stupidity may be avenged by frequent cuffs and blows, of which the ears are likely to receive a full share. Then, perhaps, some charitably-disposed person suggests that the supposed evidences of perversity or of defective mental power will soon disappear under the administration of tonics; yet still the evil continues. Nearly every day of my life do I see patients who have become deaf —many shockingly so—merely from neglected aural catarrh; and some have put off seeking advice until too late. Those cases are the most successful which have come early under treatment. Though, doubtless, what is known as a strumous diathesis has much to do with loss of hearing in a considerable number of children, still it is most requisite to eradicate from the minds of parents the fancy that their offspring will recover their hearing with improvement in their constitution. Whilst this vain hope is being indulged in, and treatment neglected, deafness from thickening of the tympanic membrane, and from the collection of thickened mucus in the tympanum, hampering the movements of the little ear-bones, is constantly on the increase. As we have already seen, the friends of a deaf child have sometimes not the slightest notion that it is hard of hearing; and, reflecting on the fault and corruption of their own nature in youthful days, they are apt to inform the little sufferer that it is careless or provokingly obstinate, and that "None is so deaf as he that won't hear." We read in Holmes's "System of Surgery" of a boy who, from early life, had been the subject of aural disease, and who actually died from abscess in the brain caused thereby, but whose father used to box his ears for what he termed "inattention." When of recent origin, aural catarrh yields readily enough to appropriate treatment. One may find that in some children the frequent opening of the Eustachian tube, and the consequent admission of fresh supplies of air into the tympanum is prevented by a habit of breathing solely through the mouth, which in some instances is due to clogging of the nostrils, swelling of the tonsils, and other hindrances to free respiration, but in others appears to be simply a trick. Many of the children whose deafness is occasioned by enlargement of the tonsils suffer from chronic colds; and, as they always keep the mouth open, they are unable to pronounce the consonants M, N, and NG, for the utterance of which the mouth-passage is variously closed, whilst the nose with its cavities performs the part of a resonator; they are erroneously said, in short, to "talk through the nose." Such children may generally be recognised by their weakly appearance, by their narrow jaws, crowded teeth, and small but always patent mouth-opening. Sometimes hearing is interfered with by an accumulation in the tympanum of fluid, chiefly mucus, in consequence of the closure of the Eustachian tubes through swelling caused by cold and damp. Air blown into the tympana through this fluid makes a rattling sound. When, in process of time, the fluid has been all expelled, the hearing is usually found restored in its integrity. From what has been said under the head of anatomy of the ear, it is evident that rarefaction of the air in the tympanum must occasion constant undue atmospheric pressure upon the drum-head; the results of this pressure may be damage to the ear both lasting and irremediable. Some deaf persons, by turning the head on one side, are able to open the Eustachian tube, and thus temporarily to improve their hearing.

Exposure to cold and damp and resultant soreness of the throat are potent in causing catarrhal inflammation of the middle ear, a chief sign of which is very severe pain. This disease is not uncommon in children, who, because it comes on with restlessness and loss of appetite, are treated with poultices to the stomach, doses of castor-oil and grey-powder, and lancing of the gums, whilst the anxious friends fail to note the important symptom—clearly pointing to the true nature of the malady—that the head cannot for pain be rested on the affected side. It must not be forgotten that affections of the ear may be secondary to the condition of the teeth and gums, which latter, moreover, may act prejudicially on the ear by rendering it peculiarly susceptible to the irritant influence of cold, and a variety of other baleful agencies. There are few persons unacquainted with the sensation of the teeth being "set on edge," and this, as Sir Astley Cooper long since pointed out, may be attributed to that part of the auditory nerve which lines the labyrinth of the ear, which through the medium of the portio dura, its anatomical associate, conveys to the nerves of the teeth the impression of acute and disagreeable sounds. We can similarly account for the affection of the ear by the eruption or decay of teeth. Singularly enough, one may sometimes discover that a diseased or badly-stopped tooth which is not in itself at all painful is the cause of neuralgia in the external auditory canal. The ear may be severely injured by the access of cold water to the inner extremity of its external canal in bathing or diving. The drum-head may be ruptured by the act of taking a header into water, or by the impact of a wave, which latter, moreover, either directly or by causing spasmodic expiratory efforts, indirectly may force water through the Eustachian tube into the drum, and so do mischief. The plugging of the ear with wool is a precaution which bathers are prone to neglect, even though they happen to be suffering from perforation of the membrana tympani, which, by allowing the direct ingress of water, or that which is still more irritating, brine, into the drum, may occasion fatal inflammation, as in the case of Lord Justice Thesiger and many others. It is a strange fact that, notwithstanding the known existence in many marine animals of special provisions for the prevention of the contact with the more delicate structures of the ear of the element in which they swim, the antiquated notion still popularly obtains that exposure to the influences of cold sea-water in bathing cannot possibly lead to any mischief.

A very severe form of deafness, due to chronic inflammation of the ultimate nerve-fibres of the cochlea or to concussion of the labyrinth, is to be met with among boiler-makers, artillerymen, and others frequently subjected to the shocks of loud and jarring sounds. It may be in great measure prevented by placing a plug of cotton-wool in the ears. Another precaution which should be adopted by those who fire heavy guns is to keep the mouth open, instead, as is usually taught, of closing it and pressing the teeth together. When an artilleryman does happen to suffer from sudden deafness—the result of rupture of the drum-head—this accident is most probably the indirect effect of decreased atmospheric pressure in the tympanum, owing to the closure of the Eustachian tube from catarrh or some other disease of the ear. That the shock of an artillery discharge does not produce sudden damage of the drum-head seems attributable to some preparatory action on the part of the internal muscles of the ear, more especially the stapedius.

It is much to be regretted that many persons, unaware that the hardness of hearing from which they suffer is the outcome of structural changes in the ear, allow themselves to be persuaded that by the use of "drops for the ear," and other quack nostrums, they will be sure to obtain relief: the defect can be prevented from increasing and be remedied only by the adoption of such curative measures as are suited to its special cause, which must, of course, be carefully ascertained previous to treatment. Some excessively cleanly people are possessed of the notion that, in order to secure the well-being of the ear, and to clear it of wax and epidermic scales, its passage must daily be drenched with oil, glycerin, or other more potent detergents—a practice as promotive of their good intention as would be the employment of a coal-heaver to dust a drawing-room.

The cerumen, or wax, of the ear is a bitter, soapy substance, five-eighths soluble in alcohol, the remainder being albumen, oil, and salts of sodium and calcium. It is sometimes entirely absent in adults. In aged persons it becomes dry and brittle, and occasionally in children it is fluid and malodorous, and may cause serious damage to the ear if not removed. Deficiency and dryness of the cerumen may be associated with diseases of the internal ear. A mass of hard wax in the ear may do much mischief, by causing thickening, excessive concavity, or perforation of the drum-head, and dilatation of the osseous meatus. Attempts to remove wax and foreign bodies from the meatus and to relieve itching must never be made with ear-picks of any kind.

An objectionable instrument, called an aurilave, consisting of a fragment of sponge attached to the end of a piece of stick, has been invented for the cleansing of the ears, which it certainly does effect in a sense, but only by thrusting the cerumen deep down into the meatus, where it forms a plug difficult to remove. The same result is brought about by the habit, indulged in by some persons, of using the twisted corner of a handkerchief or towel to clear away cerumen and other matter. In some cases an accumulation of flakes of skin in the meatus, and in others an overgrowth of hairs may obstruct the passage of sound.

It must never be forgotten that instrumental interference with the ear for the extraction of foreign bodies is rarely necessary, and is often hazardous, especially when ventured upon by the inexperienced. Almost invariably do I find that the well-meant but misdirected endeavours of the friends of a patient to dislodge foreign bodies from his ear have been productive of mischief; and cases are known of total deafness, and even fatal inflammation of the brain, resulting from ill-considered meddling with the ear, sometimes when there has actually been nothing whatever to remove. The foreign bodies met with in the ear are commonly beads, small pebbles, cherry-stones, shells, portions of tobacco-pipe and slate-pencil, sealing-wax, grass, and hardened masses of cotton-wool. This last substance, if not used in a piece of sufficient size, may find its way through a perforation in the tympanic membrane, and, after traversing the tympanum, reach the Eustachian tube.

Boils in the auditory canal are not infrequent among middle-aged persons. They are considered by some careful observers to be largely due to irritation caused by parasitic organisms; and antiseptic preparations, which are destructive of these lower forms of life, are undoubtedly of great value in the treatment of boils. Vegetable fungi may occur in the ear: the growth of one of these, a species of *Aspergillus*, is especially favoured by a warm and impure atmosphere, such as is to be found in the houses of persons who, like the Russians, endeavour to ward off the chills of severe winters by careful exclusion of the outer air.

Insects are occasional intruders into the meatus, and the presence of their larvæ therein has been known to cause severe pain. It is difficult sometimes to persuade country folk that an earwig is not the cause of their woes; and on one occasion I was guilty of deeply offending a patient by my scepticism as to the existence of a "black-beetle" in her ear. Old medical treatises contain many a strange remedy for "worms in the ear," by which designation almost every kind of aural disease appears to have been known. Bleeding from the ear takes place in various diseases, as purpura, yellow-fever, and malignant small-pox. Its usual cause is injury to the head, with fracture of the base of the skull. Very frequently it is due to rupture of the membrana tympani, either by direct injury, or by atmospheric strain upon it, as in the ascent of lofty mountains, or during a sudden descent in a diving-bell, or when, as in whooping-cough, asthma, and violent sneezing, air is driven up with great force through the Eustachian tube. The ear-passage sometimes becomes blocked up by one or more bony growths, which may be so hard as to require the employment of a dentist's drill for their removal. In cases where malformation of the auricle is met with, the ear-passage may be entirely wanting. Nature, as if to assert her right of way in the manufacture of mortals, has created some few persons with no auricles at all, whilst upon others she has bestowed more than the customary dole of two.

Upon the subject of blood-tumours of the auricle we need not here enter, except to say that where they are not caused by violence they are mostly the product of a diseased condition of the brain, and that they occur most frequently in the paralysed and epileptic insane. The auricle, like other organs of the body, may sometimes have to be removed by the surgeon, on account of malignant disease. In cold countries its exposed position renders it liable to frost-bite, in case of which the renewal of the circulation of blood in it must be promoted by bathing with only lukewarm water, or by gentle friction with ice or snow, and not by the sudden application of heat, which is apt to cause inflammation and consequent destruction of tissue. Practisers of the art of piercing for ear-rings should be especially careful, after each operation, to cleanse the instrument employed, in order to obviate the possibility of poisoning by the introduction of impurities into the blood. Dr. Constantine Paul is of opinion that a scrofulous constitution is evidenced by the formation of a linear scar or slit-like opening where the lobule is pierced; but others have suggested that the weight of ear-rings may be sufficient to account for this peculiarity. In certain cases a ring in the ear appears to play the part of a seton, acting as a counter-irritant upon the progress of eye-complaints. Of the skin-diseases that attack the ear, eczema is the most common. Chronic and, less usually, acute erysipelas of the ear are far from rare.

Itching of the ear, generally met with among nervous females in the latter half of life, especially in those whose circulation is defective, is a troublesome ailment, for which examination of the ear reveals no sufficient cause. As we have already had occasion to remark, the dropping of supposed medicaments into the ear may do it serious damage. We know of one case where a mother thought fit to put turpentine into her child's ear, with disastrous effects; and of another case where a country gentleman, acting under what he described as medical advice, swabbed his ear with a strong solution of lunar caustic, thus very thoroughly burning away his already far from efficient tympanic membrane.

It is unfortunate that in many sick persons there exists a tendency to distrust the practitioner who, called to their aid, will patiently set himself to further rather than at hap-hazard to seek to force the operations of nature in accomplishing the cure of their complaint. With them and their diseases they like daily to see that there has been "something attempted, something done;" and they fly to the officious charlatan, who will promise them, through the use of some vaunted panacea of his own, a sure and speedy passage to the heaven of restored health. And so, despite the fact that nearly all serious diseases of the ear arise on the inner side of the impervious drum-head, "drops for the ear" are bought by the poor and ignorant, and inserted with all solemnity into the outer ear-passage, and quacks continue to batten on the proceeds of shameless advertisements.

It would seem that there will always be people, even as in the dark ages, ready to accept the assertions of mountebanks with respect to the magical efficacy of their wares. It must be borne in mind that the irritation set up by fluids dropped into the ear is prone to eventuate in serious inflammation of the tympanic membrane, and consequently to cause decided impairment of its functions; indeed, certain recent experiments, independently made by Professors Brown-Séquard and Vulpian upon several small animals, tend to show that indulgence in the employment of medicinal drops for the ear in order to relieve earache and facial neuralgia is liable to produce even fatal results.

Some drugs, notably salicin and quinine, when used as internal remedies, are productive of singing in the ears and deafness. The latter in large doses induces marked congestion of the auditory apparatus, and thus if long administered may cause disease of the labyrinth and internal ear, and resultant incurable deafness.

The most common cause of ear-disease in children is scarlet-fever, and not a few cases are due to measles, whooping-cough, and mumps. When the disease is early treated, there is a fair prospect of completely overcoming it; but where allowed to take its own course it in almost every instance produces most lamentable results, among which may be mentioned aural polypus, thickening or perforation of the drum-head, destruction of the small ear-bones, the constant flow of a foul discharge, owing to chronic inflammation of the tympanic mucous membrane, and sometimes, from extension of that inflammation, abscess, or other injury of the brain, eventuating in paralysis, epilepsy, insanity, chronic vertigo, or death, or even fatal infection of the lungs by means of matter that has found its way into the internal jugular vein. It is the anatomical position of the structures of the ear that renders disease in them especially dangerous; for the upper wall of the bony tympanum has a portion of the brain immediately above it; the lower wall forms part of a fossa in which runs the internal jugular vein; the inner wall is tunnelled by the important nerve that governs the muscles of expression of the face; and the front wall abuts upon the internal carotid artery.

Otorrhœa, or running from the ear, is frequently the result of acute otitis—*i.e.*, sudden and severe inflammation of the ear—which may cause an accumulation of matter in the tympanum sufficiently great to occasion the rupture of the drum-head. The otitis may be brought on not only by fevers, but also by a blow on the head, or exposure to wet and cold in various ways. In scrofulous children otorrhœa comes on without any of the symptoms of acute otitis. In some cases of fever, deafness is an almost necessary result of the rapid disorganisation of the auditory apparatus by a discharge of sanguineous fluid into the tympanum; but in a very large proportion of cases it is traceable to the neglect of parents who, instead of seeking a cure for their child's otorrhœa, have calmly assumed that "the little thing will grow out of it." One would naturally imagine that the risks to health and hearing implied by a perpetual foul discharge from the ear would speedily impress themselves upon the public mind, yet so far is this from being the case that there are actually persons who hold the extraordinary notion that such a discharge is positively salutary; and it is one's repeated experience in hospital practice that not the malady, but simply the offence to the sense of smell occasioned thereby, is that which has at last induced a patient to seek one's aid.

When, in consequence of scarlet-fever or some other affection, otorrhœa first takes place, the discharge usually escapes through a slit-like opening in the drum-head (see Fig. 12); but, if allowed to persist, it gradually wears this opening into a round orifice (see Fig. 13), which is difficult of closure. When, therefore, the drum-head has become perforated, the surgeon's great endeavour is to restore it at once to a healthy condition, in which it can repair the narrow breach in its structures almost as quickly as it could a linear cut just made with a sharp knife.

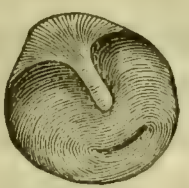

Fig. 12.—Slit-like perforation in the membrana tympani.

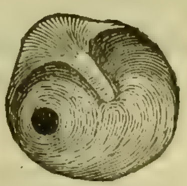

Fig. 13.—Perforation in the membrana tympani—a round orifice.

Perforation of the membrana tympani when insidiously effected by disease, scarlet-fever, *e.g.*, is very commonly left untreated for a long period; when, however, it is the direct result of a blow, it is usually attended to betimes. Snowballing accounts for a few cases of rupture of the membrana. Another cause is the brutal practice adopted by some tutors of boxing the ears of their pupils, to which were attributable eight out of five hundred (or 1·6 per cent.) consecutive hospital cases seen by the writer. The annexed figures, which show the effect that a self-appointed instructor of his spouse produced in one of her membranæ by a blow from his fist on the side of her head, might afford to some pedagogues a hint of no mean value.

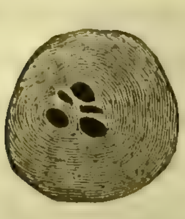

Fig. 14.—1. Exact appearance of the ruptured membrana tympani on the day after the injury.

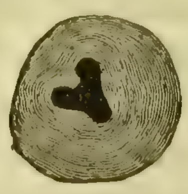

Fig. 15.—2. The appearance of the membrana on the third day.

The position, shape, and size of perforations in the drum-head, as well as their influence on the appreciation of sounds, vary very greatly. Hardness of hearing is usually the outcome of the happily rare formation of an opening through its uppermost part. The degree of audition may be very different in two patients whose membranæ present perforations which, from their history and condition, are seemingly identical in character. Many years ago, Mr. Cheselden, a surgeon, arranged that a condemned criminal should be pardoned on condition of his submitting to a direct experiment to ascertain what loss of power the ear would undergo on the making of an aperture in the drum-head; "but, a popular outcry being raised, it was thought proper to relinquish the idea."*

The aurist has sometimes to deal with cases in which the establishment of a perforation would undoubtedly be of lasting benefit to hearing. The late Sir Wm. Wilde held that a large is preferable to a small permanent aperture in the drum-head; and his opinion is supported by what Sir Astley Cooper relates of a medical student who consulted him. This person had lost the right membrane partially, while of the left not a trace was discernible, and yet he could hear better with the left than with the right ear; his deafness, moreover, was inconsiderable, and he was nicely susceptible of musical tones. One interesting discovery made with respect to this patient was that the external ear had acquired the power of distinctly moving upward and backward immediately anything was listened to that was not distinctly audible. (See "Phil. Trans.," Vol. XC., p. 152, *et seq.*) The presence and the condition of the little ear-bones determine, to a great extent, the degree of hearing compatible with perforation. When the incus is detached from the stapes, there is, as Hinton pointed out, an inability to hear anything except during the act of listening. Artificial pressure, such as that afforded by a moistened pellet of cotton-wool, is the only means by which it is feasible to improve hearing impaired by interruption in the continuity of the chain of ear-bones. Disease of the internal ear is almost always secondary to some other affection, as, for example, effusion of blood or serum into the labyrinth, injury to its structures or to the brain inflammation of the cerebral membranes, fevers, rheumatic joint-affections, and mumps. It may exist without any discoverable impairment of the condition of the membrana tympani.

In considering the functions of the organ of hearing, one must bear in mind that it is made up, first, of a sound-conducting portion—namely, the external and middle ear, together affording passage to sonorous vibrations as such; and, secondly, of a sound-perceiving portion, *i.e.*, the labyrinth with the auditory nerve, by which vibrations are accepted and assorted, and then translated into messages cognisable by the brain. When a deaf person having a tuning-fork placed on his forehead hears its vibrations louder in his more defective ear than in the other, the aurist knows that there is obstruction to sound-conveyance; when the reverse is the case, he diagnoses faultiness in sound-perception. The effect of obstruction to the passage of sound may easily be experienced by any one with normal hearing, when, one ear being closed by the finger, a vibrating tuning-fork is applied to the forehead. Disease of the auditory nerve is manifested principally in absolute deafness, and it appears that when there is affection of the terminations of the nerve in the labyrinth, giddiness, singing in the ears, faintness, and vomiting may be present. In fevers, especially typhus, failure of hearing in proportion to nervous weakness is far from uncommon, and in some cases the defectiveness of audition is persistent after convalescence, thus resembling the lasting mental incompetency occasionally observed subsequent to serious and prolonged interference with the cerebral activities. Considerable loss of hearing has been known to come on without any clearly defined cause. It would seem that in certain instances severe nervous strain avenges itself, so to speak, upon the organ of hearing more especially, its precise mode of action being as difficult to trace as in those cases where its effect is to turn the hair white in the course of a few hours. Thus, one of the author's hospital patients became almost totally deaf immediately on the announcement of the death of a child, and another suffered similarly when his wife died.

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* "Phil. Trans.," Vol. XC.

Deafness is sometimes the concomitant of the constitutional conditions prevalent for a few months before parturition, and during the period of suckling. When it occurs in bilious attacks, it is probably due, as in gout and fevers, to an impoverished and poisoned condition of the blood.

A species of giddiness caused by disease of the internal ear is known as aural vertigo, and this, with other symptoms, is specially characteristic of what, from the name of its first describer, is designated Ménière's disease, in which there is abnormal irritation of the nerve-fibres of the semicircular canals. The main peculiarities of a typical case of this disease are that the patient first experiences the sensation of a rotatory movement in a vertical position, perhaps with that of swaying to and fro; then he feels as though he were revolving forwards and backwards on a transverse axis; his vertigo now increases, and he swoons, and may vomit. Usually there are with the movements sensations of sound. In long-established cases there is slight vertigo between the seizures, a sensation of falling backwards or forwards, or a fixed and unnatural position of the head. A great similarity exists between many of the symptoms of auditory vertigo and those of sea-sickness.

Loss of hearing due to disease of the auditory nerve, or "nervous deafness," is generally most efficaciously tested by means of the tuning-fork. It yields very poorly to remedial measures, but happily is rare in comparison with other and more manageable affections of the ear.

Singing in the ears, or *tinnitus aurium*, is sometimes the accompaniment of general disturbances of the constitution, sometimes the result of direct irritation. Kramer describes it as "a completely local affection of the ear, which may be produced, and is always proportionately increased, by sympathy with general derangement of the system."

It is in most aural diseases a frequent and more or less trying symptom. Roosa and Kramer tell of two cases of suicide on account of it; and Sauvage mentions an instance of a musician who, as in a case once under the care of the author, heard in addition to every note he played a second inharmonious sound, so that he was compelled to give up his occupation. Patients affected with tinnitus aurium generally compare it to those sounds with which they are most familiar. Country folk having it for their companion must perforce, so far as sounds are concerned, from early morn to dewy eve—

> "all the pleasures prove
> That valleys, groves, or hils, or fields,
> Or woods and steepie mountains yeelds;"

but the townsman, *nolens volens*, has to bear with the rumbling of carriages, the clang of hammers, or the whirring of machinery; whilst the servant is throughout his waking hours perpetually pestered with the tingling of the bells whose summons he has been wont to obey. Most patients complain of what is termed the "tidal sound"—*i.e.*, a noise such as is heard when one holds a shell to the ear. Tinnitus aurium is usually overcome by the removal of its primary cause, whatever that may happen to be, and by the cure of the accompanying deafness.

The sound of one's own voice in the head, double hearing, or autophony (from *αὐτός*, one's self, and *φωνή*, voice) is a phenomenon by no means rare in sundry diseases of the ear. Sir Everard Home states that an eminent music-master once, after catching a cold, for a long time found that the pitch of one ear was half a note lower than that of the other, and that the perception of a simple sound did not occur in both ears at the same instant, but was rendered double, the second sound being the lower and weaker. Before dismissing the subject of the musical perception of the organ of hearing in different pathological conditions, we may mention another anecdote given by Home, to the effect that a lady who had been incapable of singing any tune, from the want of an ear for music, in the course of an attack of madness, to the astonishment of her friends, sang a tune with tolerable correctness.

Most of us can call to mind examples of the curious mental effects produced by various sounds heard during sleep or a drowsy condition. Shakespeare has told us how, when Queen Mab drums in his ear, the soldier "starts and wakes; and, being thus frighted, swears a prayer or two." The vibrations of a pair of tweezers close to his ear as he slept M. Maury found to occasion dreams of bells, the tocsin, and the events of June 1848; and a lover, we read, effected a change of sentiments in his obdurate fair one by whispering his name in her ear when she was slumbering, thus inducing a happy habit of dreaming about him.*

The census statistics of several European and American countries within the last half century reveal the somewhat startling fact that one person in about 1,650 is a deaf-mute—*i.e.*, is both deaf, and though not, as a rule, potentially, yet virtually dumb. Deaf-mutes are divisible into two groups—viz., the congenitally mute, whom deafness at birth has deprived of the infant's facilities for learning to speak, and those who are mute because deafness has come on sufficiently early in life to prevent either the acquisition or else the retention of speech. The relative proportion of these two groups in any given population, it is, from various circumstances, difficult with any certainty to determine; but it appears that at the British census for 1871 sixty-three per cent. of the inmates of twelve institutions for deaf-mutes were congenitally affected. Fevers and other inflammatory diseases, and falls and blows are common causes of non-congenital deaf-mutism, especially in scrofulous subjects; and inherited tendency, and indubitably ill-assorted marriages and the inebriety of parents are potent in producing the congenital affliction. It is noteworthy that the congenitally deaf are rarely free from more or less well-marked constitutional defect of some sort; still it must not be supposed that the comparatively high mortality exhibited by deaf-mutes is altogether attributable to this fact, for diseases affecting the circulation and respiration, to which they are specially liable, are precisely what their usually sedentary habits and, in cases where articulation is not learnt, their mouth-breathing and deficient exercise of the lungs render one prone to contract. Observation and experience as an aural surgeon have constrained the author to accept the conclusion that where congenital deaf-mutism is not traceable to any kind of inherited taint or family defect, it is, generally speaking, due to the close relationship of the parents, they commonly being first-cousins. Dr. A. Hartmann has called attention to the following results of recent very exact statistics, which, as he truly observes, positively prove that consanguineous marriages are a cause of congenital deaf-mutism:—In Prussia, where the total number of consanguineous marriages yields a percentage of 0·8, there were among 1,210 congenital deaf-mutes 156, or 12·9 per cent., who were the offspring of consanguineous marriages; while among 1,551 individuals with acquired deafness there were only 47, or three per cent., who sprung from such marriages.

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* See James Sully, "Illusions," p. 140.

The systems that have been most generally adopted for the instruction of the deaf and dumb are known as the "French," or "old;" the "old English," or "combined," and the "German," or pure oral. Of these, the first aims simply at the expression of thought through the intervention of signs and gestures, or dumb-show, and of words spelt with a finger-alphabet. By this system diligently learnt the deaf-mute, as Kitto, who was himself deaf from the age of twelve, admits, may indeed become possessed of "the solid bones, the dry bread, the hard wood, the substantial fibre of life," but gets "little of the grace, the unction, the gilding, and the flowers, which are to be found precisely in those small things which are not worth reporting on the fingers."

The old English system embraces speech, together with natural and artificial signs of all sorts, and reading from the motions of the lips. The German system, rejecting all manner of signs and symbols, imparts, by means of sight and touch, an exact and practical knowledge of articulate speech, so that the deaf-mute, by dint of practice, may be able with readiness both to utter all its various combinations of sounds and to read them from the lips of others. The German is sometimes designated the "new" system, though, as Kinsey remarks, it was in vogue long before any method of signs was introduced. Its principles, we may surmise, were those upon which a certain Dr. Amman, at about the close of the 17th century, taught a girl of seventeen to speak very intelligibly, and to read Dutch and Latin. (See Charles Ellis, "Phil. Trans.," 1703, p. 1416). The slowness with which its advantages have come to be perceived in England is perhaps due in part to a popular persuasion that deaf mutes are by nature dull of sight and apprehension, and could not, therefore, overcome its intrinsic difficulties. It is reported that but lately the usher of a British court of justice, asked why he was writing the questions for a deaf person in words some inches long, replied, without a moment's hesitation, "Because the witness is so deaf!"

Although the ear is undoubtedly in close organic connection with the voice-producing mechanism, the success of teachers of the pure oral system of instructing the deaf and dumb proves beyond all controversy the untenableness of the notion which some have held, that there is associated with deafness, and quite independent of it, a sort of physical inability, as well as a disinclination, to utter articulate sounds. So little was this system understood in England some few decades since, that writers on the education of the deaf and dumb were disposed to regard an imperfect mastery of it as a phenomenal achievement, and gravely expressed their thorough persuasion that "mouth-reading must be wholly inadequate to the purposes of real conversation, involving intercourse of the intellect or the imagination," and that "writing and signs are abundantly sufficient for all the intercourse to which a deaf-mute is equal." Now, however, it is very generally recognised, and can be abundantly proved, that signs, gestures, finger-alphabets, and even phonetic symbols are not only unnecessary for the requirements of those deaf-mutes to whom can be afforded the opportunity of learning oral speech and lip-reading, but actually serve as so many serious obstacles to their intellectual advancement. Even were the language of signs a codified system common to all institutions and countries, which it emphatically is not, it could but enable the deaf to communicate with the deaf. Unfortunately, it has been found, in proportion to its use, to prevent the acquisition of oral speech and lip-reading, by means of which alone can dumbness and its many sad accompaniments be practically abolished. It was some forty years since that Kitto, writing of deaf-mutes, said: "It is an idle dream to hope to restore such persons entirely to society;" still, thanks to the dissipation of prejudice, and to the spread of knowledge, this "dream," long ago realised on the Continent, has of late years in England also had its ample fulfilment in irrefragable facts.

Aids to Hearing.—Most instruments employed for the improvement of defective hearing are constructed with a view to the augmentation of resonance within the external ear, and the reflection into it of waves of sound. It is for these purposes that the deaf man places a hand behind his ear. The instrument called an otophone increases the receptive power of the auricle by causing it to project forwards. Hard and compact bodies—*e.g.*, metal, glass, and porcelain—are the most efficient reflectors of sound; but many such materials are practically inadmissible for the manufacture of ear-trumpets, on account of their weight or fragility, or their peculiar note when subjected to vibration.

A hollow cone forms a good sound-reflector, the efficacy of which may be enhanced by widening and obliquely truncating its base. The instrument is thus made not unlike the ears of some quadrupeds. Transverse vibrations of the air within it are found to be diminished by piercing the sides with several holes. Some deaf persons are greatly benefited by the use of small globular or conical metallic resonators. Double aural instruments are those generally found most efficacious. When the sound-collector is furnished with a tube, the free end of the latter must be of a size to fit accurately into the auditory meatus.

That an ear-trumpet may form a useful social weapon of defence, we perceive from the lines of Goldsmith on Sir Joshua Reynolds, telling us that—

> "To coxcombs averse, yet most civilly steering,
> When they judged without skill he was still hard of hearing;
> When they talk'd of their Raphaels, Correggios, and stuff,
> He shifted his trumpet, and only took snuff."

In foreign countries, however, the employment of an ear-trumpet might possibly lead to untoward and somewhat embarrassing results, as the following true story serves to indicate:—A deaf old lady in India was asked out to dinner, at which she seemed to be thoroughly enjoying herself, until, at length, one of the native servants asked her whether she would take some green peas. Not hearing the question, she raised an enormous silver trumpet to her ear, exclaiming, "What does the stupid man say?" Whereupon the servant, evidently regarding the trumpet as some new-fangled implement of European epicureanism, poured into it a good spoonful of the peas.

The different forms of resonator and sound-conductor that have been invented for the relief of deafness are exceedingly numerous. Experiment alone can prove which of these is likely to prove of most service to a patient; and the same may be said of the several kinds of artificial drum-heads.

Some deaf persons are acutely affected by vibratory impulses conveyed through the tissues of the body to the auditory nerve; thus, Kitto found that every movement or concussion in a wooden-floored uncarpeted room caused him a sensation amounting to torture.

The possibility of hearing through the teeth and other structures has been thought to be enhanced by a lax state of the membrana tympani. It has been rendered available for some cases of impaired audition by the invention of the audiphone, osteophone, tonomittor, and other forms of solid sound-conductors. Some few experiments that have been made with the audiphone tend to prove that it is unlikely to be of any use for the instruction of deaf-mutes.

THE THROAT, VOICE, AND SPEECH.

By John S. Bristowe, M.D., F.R.S.,

Senior Physician to St. Thomas's Hospital.

Introduction—Structure of Nose; of Mouth; of Throat; of Larynx—Function connected with Digestion, Respiration, Voice, Speech—Functional Derangements connected with Mucous Surface, Chewing and Swallowing, Paralysis, Spasm—Affections of Respiration; of Voice; of Speech—Defective Articulation—Stammering—Blundering Enunciation—Forgetfulness of Names—Hints as to Public Speaking and Singing—Catarrh—Accidents to be Avoided.

Whether we regard them physiologically, or in their relation to disease, there are few, if any, more important and interesting parts of the body than those that are concerned in the production of the voice and speech. Placed immediately above the windpipe and gullet, and lying between these below and the mouth and nostrils above, they form a common antechamber to them, and the only channel by which air can be supplied to the lungs for the purposes of respiration, and food conveyed to the stomach for the purposes of nutrition. Hence these organs not only subserve the functions of voice and speech, which have a special relation with respiration; but they are the organs of smell and taste, and those for the prehension, mastication, and swallowing of food.

It is wonderful, as we pass, step by step, from the lower forms of animal life to such as are highest in the scale, and thence to man, to observe how parts that are primarily devoted solely to the maintenance of life—at first to the selection, prehension, and preparation of food for digestion, and later to the respiratory function as well—become also adapted to the performance of higher duties which the growth of intellect depends on and demands; and how the comparatively simple mechanism, which subserves these heterogeneous functions, not only remains perfect for its primary purposes, but proves itself at least as marvellous an instrument for its more complex, various, and delicate superadded duties.

The organs to which we have mainly to confine our attention in the present article are bounded above by the anterior part of the base of the skull, behind by the spinal column, and below by the upper outlet of the chest, the collar bones, and the parts connected therewith; and they comprise the mouth and nose, with their appendages, the fauces, the larynx and upper part of the trachea, and the commencement of the œsophagus or gullet. It would be difficult, however, if not impossible, to understand the duties they have to perform, and the mode of performing them, without some reference to subsidiary organs, not included in this district; and such a reference, therefore, will here and there be made in the course of the subsequent pages.

STRUCTURE.

The Cavity of the Nose occupies the central region of the face, lying between the base of the skull above and the roof of the mouth below, and bounded on either side by the orbits (or cavities containing the eyes) and the cheek-bones. Its anterior limits are the facial projection, which constitutes the nose proper; its posterior limits the posterior nares or nostrils, which, extending obliquely from the skull above to the palate below, allow of a very free communication between the cavity of the nose and the upper compartment of the pharynx. The cavity of the nose, however, is not nearly so simple as the above brief description might lead one to suppose. For, first, it is divided into two parallel vaulted compartments by a vertical septum, which extends uninterruptedly throughout its whole antero-posterior extent; second, its outer wall on either side has connected with it three projecting, twisted shell-like films of bone, extending horizontally from back to front, and imperfectly dividing each lateral compartment into three galleries or meatus; and third, several diverticula, or caverns, open out of these compartments—one on either side, into the upper jaw-bone, immediately under the eye; and one also, on either side, into the frontal bone, where it helps to cause the prominence (particularly noticeable in some persons) immediately above the bridge of the nose and inner extremity of the eyebrows; and others into the ethmoid and sphenoid bones. Further, a direct channel passes on either side from the puncta at the inner extremities of the eyelids into the inferior meatus, along which tears travel from the surface of the eye to the interior of the nose.

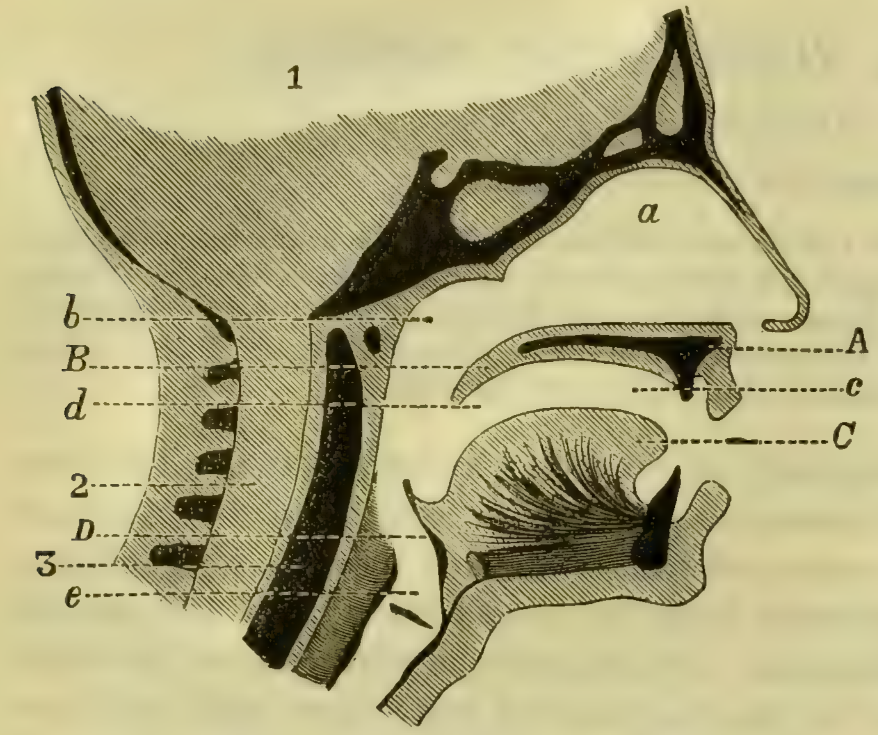

FIG. 1.—VERTICAL SECTION FROM BEFORE TO BEHIND OF NOSE, MOUTH, FAUCES, LARYNX, AND ADJOINING PARTS.

1, Cavity of skull; 2, Spinal canal; 3, Bodies of vertebræ; A, Hard palate; B, Soft palate and uvula; C, Tongue; D, Epiglottis; *a*, Cavity of nose; *b*, Pharynx; *c*, Cavity of mouth; *d*, Fauces; *e*, Larynx.

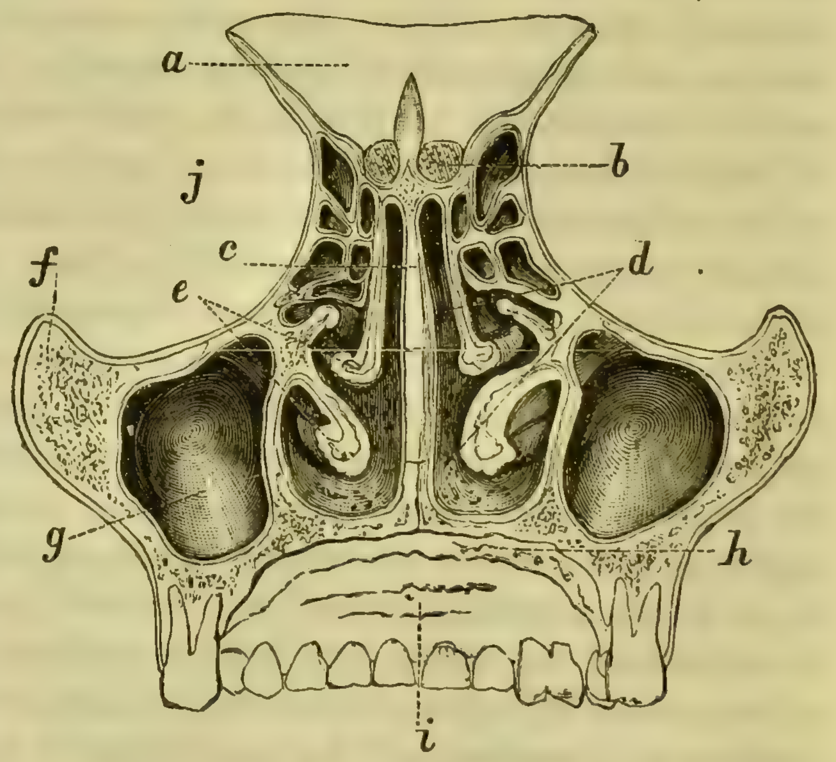

FIG. 2.—TRANSVERSE VERTICAL SECTION OF NOSE, SEEN FROM BEHIND.

a, Frontal bone; *b*, Olfactory nerve on base of skull; *c*, Septum of nose; *d*, Cavity of nose; *e*, Turbinate bones; *f*, Cheek bone; *g*, Maxillary sinus; *h*, Palate; *i*, Cavity of mouth; *j*, Cavity for eye or orbit.

The primary purposes of the nose are for smelling and for breathing. The greater part of its complex cavity is invested in a mucous membrane, which being abundantly supplied with thin-walled veins, is eminently adapted to warm the air in its passage from without to the lungs, and must obviously be regarded physiologically as belonging to the respiratory tract. The upper part only is devoted to the sense of smell. It is supplied with a special form of mucous membrane, and has distributed over its surface the branches of the olfactory nerve (the nerve of smell), derived directly from a special part of the brain which lies immediately upon the thin plate of bone separating the cavity of the skull from that of the nose.

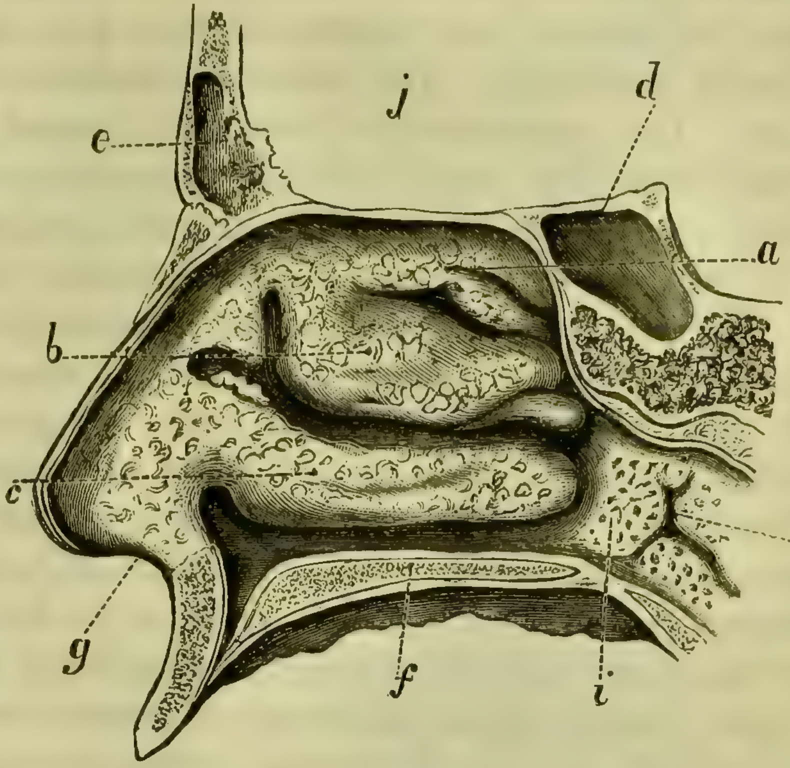

FIG. 3.—VERTICAL SECTION OF NOSE FROM BEFORE BACKWARDS, SHOWING RIGHT SIDE.

a, Superior turbinate bone; *b*, Middle ditto; *c*, Inferior ditto (the upper, middle, and lower meatuses, are below the corresponding bones); *d*, Sinus extending from nose into sphenoid bone; *e*, Sinus extending from nose into frontal bone; *f*, Palate; *g*, Nostril; *h*, Orifice of communication with ear; *i*, Posterior nostril; *j*, Cavity of skull.

The Mouth is a much larger, much more complicated, and much more important organ than the nose. It is bounded laterally by the cheeks, anteriorly by the oral orifice or mouth proper, behind by the arch of the fauces, above mainly by the palate, and below by the soft tissues included between the horizontal rami of the lower jaw, and from which the tongue springs. The cavity may be considered to be divided into two parts—first, that formed by the sulci, grooves or pouches, which intervene both above and below, between the gums and teeth on the one hand, and the cheeks and lips on the other; and, second, all that central region which is bounded laterally by the gums and teeth, is roofed in by the palatal arch, and the floor of which is occupied by the tongue.

Of the *peripheral part of the oral cavity* it is sufficient to mention that its presence, allowing the unembarrassed movement of the lower jaw, facilitates mastication, and that into it anteriorly the mouth itself opens directly.

The *Gums* and *Teeth* form two horizontal arches, with the crown in front and the base behind, of which the upper is naturally a little larger than the lower, and overlaps it. The gums are the fleshy coverings of the alveoli or sockets of the jaws, in which the roots of the teeth are firmly embedded. The teeth, as is well known, are of different kinds. The central four in either jaw, which are furnished with a cutting chisel-like edge, are the incisors. External to the incisors come the canine or tearing teeth, which are particularly strong and pointed, and which, in purely carnivorous animals, are always highly developed. These are four in number. Next to the canine are placed the bicuspid teeth, two on each side, both above and below; and beyond these again the large molars, or grinders, of which there are altogether twelve, and whose purpose is to grind or triturate the food submitted to them. The above brief description applies only to the second set. The first, or milk teeth, as they are called, are much smaller than their successors, and, immediately beyond the canines, consist of small molars only, which, collectively, are eight in number.

The *Palate* springs from the inner margin of the upper dental arch, and forms a vaulted roof to the central area of the mouth. Its basis is the same bony expansion that constitutes the floor of the nose, and it is covered by mucous membrane. The anterior two-thirds only of the palate are osseous and rigid. The posterior third, which is termed the soft palate, and which is prolonged from the other, is formed essentially of mucous membrane and muscular tissue, constitutes a movable flap, and terminates behind in two concave scallops, or arches, separated by the projecting conical process known as the uvula.

The *Tongue* is situated within the cavity of the lower dental arch. This is a somewhat flattened conical organ, which, when lying at rest, occupies the whole of the space bounded by the lower teeth: its point lying just behind the incisors; its lateral edges being pressed against the bicuspids and molars; its dorsum presenting a convexity facing the palate; its base (behind) being united to the movable hyoid bone (from which, also, the larynx and trachea are suspended), and to several other important parts which will by-and-bye be discussed; and its under aspect (which, in the greater part of its extent, is free) being attached to the floor of the mouth by a narrow longitudinal duplicature of mucous membrane, between the layers of which is contained a series of muscles which, springing partly from the hyoid bone and partly from the lower jaw, are largely instrumental in effecting the varied movements of the organ. The tongue is made up mainly of interlacing muscular fibres, which, in association with the muscles attached to it, enable it to execute the most varied movements with the utmost precision. It is covered, except on its under surface, with large papillæ, and is endowed, not only with extreme sensitiveness to tactile impressions, but is the main seat of the sense of taste.

The Fauces constitute the posterior orifice of the oral cavity, as the mouth constitutes its anterior orifice; and here, as in the latter situation, the channel becomes constricted. They are formed by the arch of the soft palate above, the sides of which are continued into two slightly divergent descending columns, formed mainly by projecting bands of muscular tissue, and known as the pillars of the fauces. Of these the anterior one blends with the side of the base of the tongue, while the posterior one loses itself in the walls of the pharynx; and between them is situated the tonsil.

The Pharynx is the somewhat irregular cavity or bag, with muscular walls, into which the posterior nares and the fauces open. It extends from the skull above to the level of the cricoid cartilage below, and is in contact behind with the anterior part of the spine, and the muscles and other parts attached thereto. It is narrow from before backwards, but comparatively wide in all that region of it which is directly related with the nose and mouth. But below it assumes a funnel-like shape, and blends with the narrow, cylindrical œsophagus. Besides the orifices already referred to as opening into it (namely, the nose, mouth, and œsophagus) there are yet three others, two of which (the Eustachian tubes leading from the ears) open, one on each side, above the level of the soft palate; while the third is the laryngeal orifice, which lies immediately behind the base of the tongue, and in front of the œsophagus.

The soft palate, in its movements and its relation to the pharynx, is so constituted that when at rest it hangs down, partly closing the posterior orifice of the mouth, but leaving the communication of the nose, through the pharynx, with the larynx and œsophagus, free and uninterrupted; when in action, on the contrary, it assumes a nearly horizontal position, and forms a complete septum between the upper part of the pharynx, into which the nose and ears open, and the lower part, whose relations are directly with the mouth, larynx, and œsophagus.

Of the *Œsophagus* nothing more need be said than that it is a muscular tube, in the adult nine or ten inches long, which leads from the pharynx to the stomach, and whose special function it is to carry food from the mouth to the latter organ.

The Larynx and Trachea constitute the common channel along which air is transmitted to and from the bronchial tubes, and hence to and from the lung-tissue. The tube commences at about the level of the horse-shoe-shaped hyoid bone (from which it is suspended, and to which the base of the tongue is also attached), and runs down in the front of the neck parallel with the œsophagus, which is behind it, into the upper part of the chest, where it divides into two branches, one for each lung.

The *trachea* is the longer, narrower, and simpler part of the tube. It measures in the adult from three-quarters of an inch to an inch in diameter, and is formed partly of muscle, partly of connective tissue, partly of mucous membrane; and is furnished also with a series of cartilaginous rings (imperfect behind, and circumscribing the tube for three-quarters of its circumference), which from their firmness and elasticity impart strength and permanence of shape to the tube.

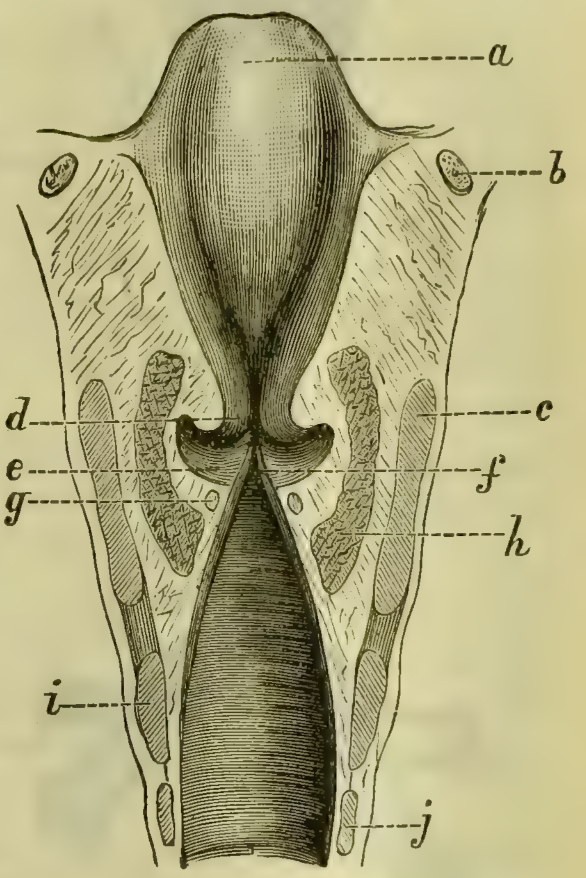

FIG. 4.—VERTICAL TRANSVERSE SECTION OF THE LARYNX.

a, Epiglottis; b, Hyoid bone; c, Thyroid cartilage; d, False vocal cord; e, Sinus; f, Glottis; g, True vocal cord; h, Thyro-arytenoid muscle; i, Cricoid cartilage; j, First ring of trachea.

The *larynx* is much more irregular in form, much more complicated in structure, and much more difficult to describe than the trachea, or indeed than any of the parts which have hitherto claimed our attention.

If we look into it from above, in its natural state, we find it immediately below and behind the base of the tongue, to which it is united by direct continuity of tissue. Its upper orifice, which is bevelled off from before backwards, is irregularly oval but variable in shape: bounded in front by a vertical plate named the *epiglottis;* behind by the upper points of the two *arytenoid cartilages;* and laterally by folds of mucous membrane, passing downwards and backwards from the lateral edges of the epiglottis to the arytenoids.

At some little depth (an inch or an inch and a half) below the summit of the epiglottis, and perhaps one-half or one-third that distance below the tops of the arytenoids, we observe another and narrower orifice, which is called the *rima* *glottidis.* This occupies a horizontal position, and varies in form according to circumstances; being sometimes a linear chink, taking an antero-posterior direction, sometimes an isosceles triangle, with the apex pointing forwards. The margins of this orifice are formed by white elastic bands (the *vocal cords*), enclosed in duplicatures of mucous membrane, derived from that which lines the walls of the larynx. Above, and a little further apart than these, are two other horizontal duplicatures of membrane—one on each side. Between each of these duplicatures and its corresponding true cord is an interval or chink leading to a small blind cavity termed the *sacculus laryngis.*

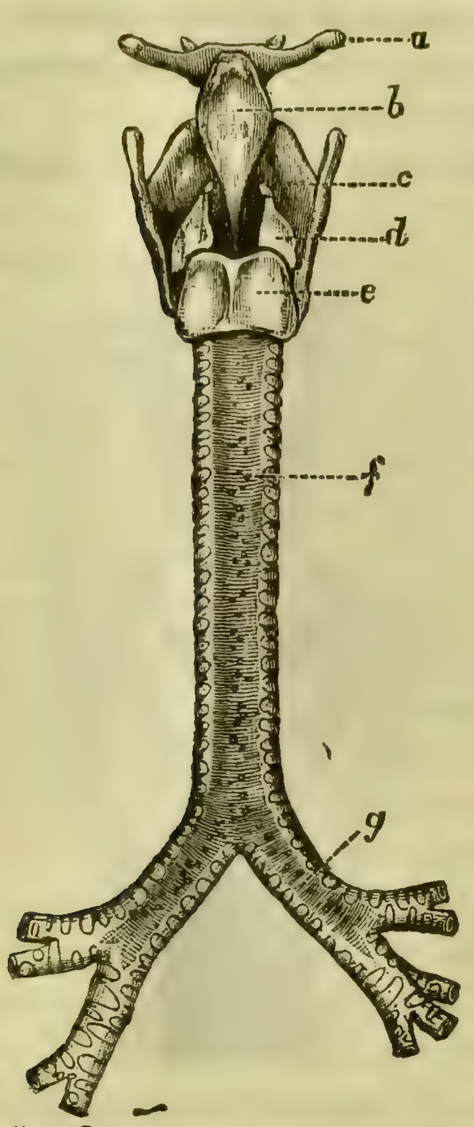

Fig. 5.—Outline showing General Form of Larynx and Trachea, as seen from behind.

a, Hyoid bone; *b*, Epiglottis; *c*, Thyroid cartilage; *d*, Arytenoid cartilage; *e*, Cricoid cartilage; *f*, Trachea; *g*, Bronchus.

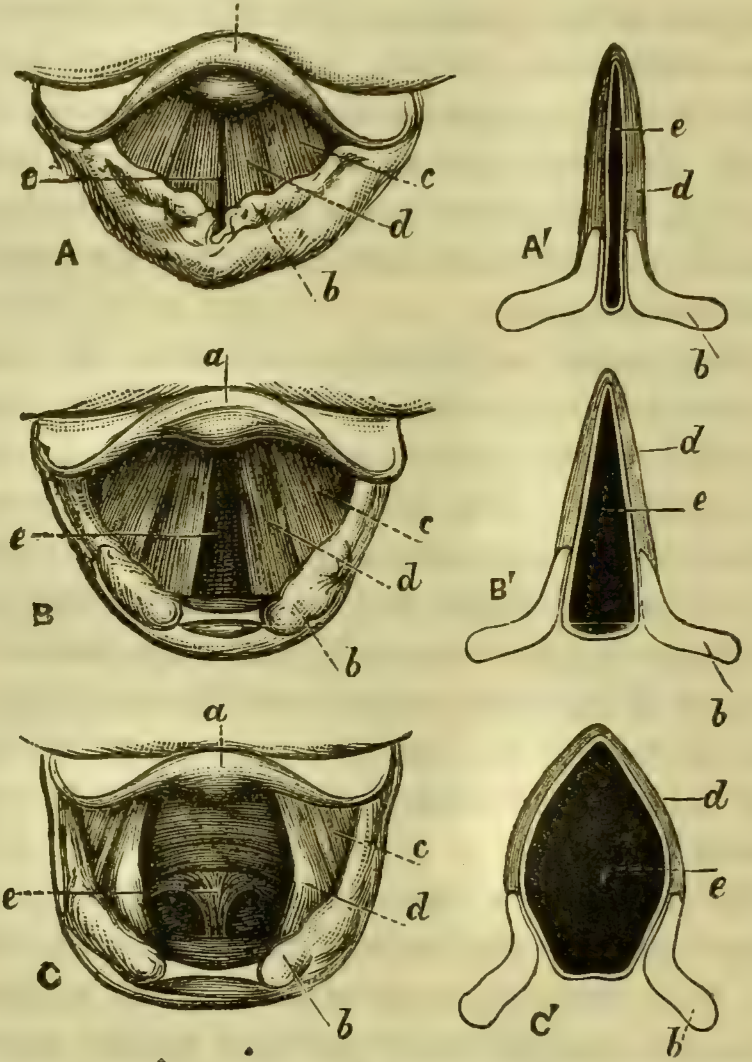

Fig. 6.—Three Views of the Superior Opening of Larynx, seen from above; and Three Corresponding Diagrammatic Views of the Chink of the Glottis.

A A′, Glottis closed as during formation of a high note. B B′, Glottis open, as in easy respiration. C C′, Glottis wide open, as in drawing a deep breath. *a*, Epiglottis; *b*, Arytenoid cartilage; *c*, False vocal cord; *d*, True vocal cord; *e*, Chink of glottis.

If we look into the larynx from beneath, we shall see that its lower part almost exactly resembles the trachea in size and shape; except that it forms a kind of dome above, the summit of which is occupied by the chink of the *rima glottidis.*

The chief points concerning the movements of the larynx are :—1st, that, in the act of swallowing, the vertically placed epiglottis descends with the base of the tongue over the upper opening of the larynx, and so prevents the entrance of food into the air passages; and 2nd, that, by the action of the numerous small muscles which act on them, the vocal cords are capable of being separated during respiration, and of being approximated and brought into contact with one another during the utterance of vocal sounds, and further (especially while in the latter position) of being stretched longitudinally and rendered tense, and of being shortened and relaxed.

Before dismissing the anatomy of the larynx, a few further facts may be pointed out. Its framework, like that of the trachea, is formed of cartilages, which are connected with one another partly by ligaments, partly by muscles, and partly by distinct articulations or joints. The chief cartilages are the *thyroid*, the *cricoid*, the two *arytenoids*, and the *epiglottis*.

The *thyroid*, which has something of the shape of the spout of a pitcher, is formed of two nearly quadrilateral plates, which unite at an angle in front, forming in man the *pomum Adami*, but diverging somewhat behind, and remaining separated by a considerable interval. The posterior edges are prolonged above and below into somewhat elongated processes, of which the superior one on each side is attached by ligament to the corresponding extremity of the hyoid bone, while the inferior and shorter one articulates with the side of the cricoid cartilage.

The *cricoid cartilage* forms a complete ring, which is narrow in front and deep behind, and so formed that, while the lower orifice is horizontal and circular, the upper one is oval, and faces upwards and forwards. Its anterior part lies immediately below the front of the thyroid, to which it is united by a ligament; while the posterior rises into the concavity of the thyroid, and its sides, as before stated, are articulated with the lower processes of that cartilage. On either side of the median line behind, the upper edge of the cricoid presents an articulating surface, to which one of the arytenoid cartilages is united.

The *arytenoid cartilages* are three-sided cones, the apices of which are directed upwards, while the bases resting on the cricoid, on the articulating facets of which they move as on a pivot, are also triangular. Each base, therefore, presents three points: one directed forwards, to which the corresponding vocal cord is attached; one directed outwards, and giving insertion to certain muscles; and one (less prominent than the others) directed backwards and inwards, and closely related to the articulating facet.

The *epiglottis* is a leaf-like body, somewhat pear-shaped in outline, with the broader extremity above, and the narrower extremity (which springs from the thyroid in the angle formed by the junction of its quadrilateral plates) below.

The *vocal cords* are united side by side in front to the thyroid cartilage, close to the attachment of the epiglottis, and behind, as before stated, to the anterior processes of the arytenoids. The false cords are attached to the same parts immediately above.

All the structures above described are united to one another by complex ligaments and muscles, and are covered in by a layer of mucous membrane.

It will probably not be difficult now to understand the mechanism by which the glottis opens and closes, and by which the cords become stretched and relaxed. The anterior extremities of the cords being united to the thyroid cartilage are practically immovable; but the posterior (being attached to the long anterior processes of the arytenoids which are capable of revolving horizontally round the articulating facets situated behind) admit, according to the movements of these processes, of being brought into absolute contact, or of being widely separated. The tension of the vocal cords is determined by the separation or approximation of their points of attachment—namely, the posterior surface of the thyroid cartilage and the arytenoid cartilages. This function is performed by the rotation of the thyroid cartilage in the vertical direction on the joints by which it is attached to the cricoid. The cricoid remaining fixed, and consequently the articulations of the arytenoids remaining fixed, the upward movement of the thyroid causes the anterior attachments of the vocal cords to approach nearer to their posterior attachments, and the cords consequently to be shortened, and rendered less tense; while the downward movement of this cartilage causes the anterior and posterior attachments to recede from one another, and the cords to be stretched.

Glands connected with Mouth and Throat.—To the above brief account of the anatomy and physiology of the parts concerned in speech and voice, mastication, deglutition, &c., it must be added: 1st, that the mucous membrane is everywhere thickly studded with small embedded mucous glands, the secretions of which keep the surfaces moist, and protect them; 2nd, that six salivary glands, of which the two largest are situated behind the angles of the lower jaw, discharge their secretions into the mouth, in order mainly to assist in masticating, swallowing, and digesting food; and 3rd, that embracing the upper part of the trachea in front and laterally, there is a peculiar two-lobed gland, the thyroid body, the use of which is not understood, but which has remarkable relations to various forms of disease.

FUNCTION.

Having now briefly considered the anatomy, and touched on the physiology, of the organs to which our attention has to be specially devoted, we shall proceed to discuss in a little more detail the actions and uses of these organs.

And first let us consider them in connection with the digestive functions.

Digestive Functions.—There is no doubt that the mouth has special relations with the alimentary canal, and may be regarded as its commencement; and that the nose has special relations with the respiratory apparatus, and constitutes the proper channel for the entrance and discharge of the air in breathing. At the same time it must be admitted that the nose, especially in the lower animals, is intimately concerned with the selection of suitable nourishment; and that the mouth takes a leading part in the functions superadded to respiration—namely, speech and vocalisation.

Sensation.—The mucous membrane of the mouth and fauces is generally extremely sensitive, and parts of it are endowed with specific sensory properties. The lips and tongue are exquisitely delicate organs of touch. The tongue, mainly at its tip, and edges, and root, and also the soft palate, and some of the neighbouring parts, are the special seats of the sense of taste. And it is to the fauces that the sensation of thirst is particularly referred; and their irritation causes nausea and vomiting.

Mastication, etc.—When solid food is taken into the mouth, as in biting a slice of bread-and-butter, the detachment of the mouthful from the rest of the mass is effected by the incisor or cutting teeth. If a piece of tough crust be encountered, the incisors are probably found insufficient for the purpose, and the canine, or tearing teeth, are called into requisition. But when once received into the mouth, the mass is conveyed to one or other side, is kept between the grinders by the action of the tongue and cheek, and (partly by crushing, partly by grinding) is gradually reduced into a pulpy mass suitable for reception into the stomach. This preparation of the food is largely aided by the fluid secretions of the mouth, which flow especially abundantly during the process of chewing or masticating, and, mingling with the disintegrated food, convert it into a soft, plastic mass. The fluids here referred to are, partly the mucus, which is yielded from all parts of the mucous membrane, but mainly the secretion of the salivary glands, which has a specific influence in converting starchy matters into substances of greater solubility, and more fitted for ready absorption into the system.

Deglutition or Swallowing.—The food thus prepared is then conveyed to the stomach. The process by which it is conveyed is really simple, but like many other simple processes difficult to describe. It has to find its way to the back of the mouth, thence through the faucial aperture, thence into the pharynx, thence along the œsophagus, and finally into the stomach. It has, moreover, while traversing the pharynx, to be prevented on the one hand from passing into the nose through the posterior nares, and on the other hand from slipping into the larynx, over the upper orifice of which it necessarily passes in its course.

The process is effected in the following manner. The bolus of masticated food is carried by voluntary effort to the back of the mouth, this conveyance being effected mainly by placing it first on the dorsum of the tongue, and then (beginning in front and proceeding gradually backwards) forcibly pressing the tongue against the palate. In this way the bolus is carried back into the fauces, where all voluntary control over it ceases. The fauces involuntarily contract upon it, and, with the aid of the back part of the tongue, squeeze it onwards into the pharynx. Then the muscular walls of the pharynx contract upon it, propelling it into the œsophagus; which tube, contracting with a powerful and rapid undulating movement, commencing above and travelling downwards, conveys it in a few seconds into the stomach. The intrusion of food into the upper compartment of the pharynx, and consequently into the nose (and, may-be, into the Eustachian tubes) is prevented by the concurrent action of the soft palate, which closes the communication between the lower and upper parts of the pharynx; and the entrance of food into the larynx is guarded against, partly by the approximation of the vocal cords, and the consequent closure of the *rima glottidis*, but mainly by the closure of the upper opening of the larynx by the backward pressure of the tongue, and the falling back of the epiglottis over it.

It may be added that, not only in certain paralytic conditions affecting the fauces, soft palate, and larynx, do these protective mechanisms often fail to act, but that occasional failure may result from accidental circumstances, as when a sudden cough or a sudden inspiration occurs at the moment of swallowing, and the food consequently is propelled in part into the nose, or "goes the wrong way."

The *swallowing of fluids* is effected in precisely the same way as the swallowing of solids, but is so far more difficult that any disarrangement of the mechanism is attended with more liability to choke in the former than in the latter case.

The process of *sucking*, as performed by babes, consists essentially in forming a vacuum in the central part of the mouth between the tongue and palate, and then compelling the milk or other fluid to flow into it, whence it is conveyed to the back of the mouth and swallowed in the usual way.

Respiratory and Associated Functions.—The proper respiratory passages, so far as we have to do with them, are the nose, pharynx, larynx, and trachea. But in order to complete the enumeration of the true respiratory organs, we must add the bronchial tubes and lungs, which are contained in the cavity of the chest, and the thoracic parietes, by the alternate expansion and contraction of which air is alternately drawn into and expelled from the lungs.

The introduction of air into the lungs is for the purpose of conveying the oxygen of the atmosphere, primarily into the ultimate tissues of the lungs, and thence (through the agency of the blood) to the general organism; wherein it acts directly in oxidising or slowly burning the effete or waste products of the body, and so promoting their discharge from the system through the several excreting organs whose function it is to separate such products, and indirectly (through the heat generated in the process of burning) but not less importantly in maintaining the bodily temperature. The act of expiration effects the double object of removing the deoxidised, and therefore no longer suitable, air from the lungs, in order to make room for a fresh and purer supply, and of discharging from the body carbonic acid gas, which is one of the important products of oxidation in the system, which imparts to the venous blood its relatively dark or venous hue, which in even moderate excess is a deadly poison, and for the separation or excretion of which no other organ than the lung is available.

The alternate movements of inspiration and expiration, therefore, are essential for the preservation of life; they are constantly performed at the rate of about eighteen a minute, both sleeping and waking, and (in health) without sensible effort; they cannot be restrained for many seconds without a sense of distress, which rapidly augments while the period of suspension of respiration is maintained, and ere long becomes insupportable; and if they be arrested by mechanical or other means, which cannot be overcome, death, preceded by insensibility, ensues in the course of a minute or two.

We have already pointed out that, while the nose is doubtless the primary and special channel for the entrance and discharge of breath, the mouth is not only capable of performing the same function, but under certain conditions constitutes the chief or even sole agent in the performance of this duty. But we repeat that for the simple purpose of respiration the nose has special endowments. In its lower chambers (which are mainly concerned in respiration), the epithelial lining, like that of the larynx, trachea, and bronchial tubes, is endowed with peculiar vibratile fringes, termed "cilia," whose purpose is respiratory; while the mucous membrane is largely vascular, and the channels are narrow and tortuous, so that the air in its passage over and along them becomes delayed and warmed, and thus rendered suitable for admission into the lungs. When, however, respiration is effected by the mouth, as happens when the nose is obstructed from any cause, and also occasionally during sleep, the evaporation of the moisture of the mouth which attends it always makes the mucous surface of this part clammy or dry and uncomfortable.

The functions which, so to speak, are engrafted on respiration are smelling and speech.

The *sense of smell* may be regarded in some degree as a simple adjunct to the sense of taste (with which it has close physiological relations), and as a guide in the choice of food. It is also a guide to us in the detecting and avoiding of agencies likely to be deleterious when drawn into the lungs. But like our other senses it constitutes, apart from its primary object, one of our important sources of pleasure. Gaseous fluids, in their ordinary tranquil journey from the anterior nostrils to the lungs, scarcely reach the olfactory region, and delicate or faint odours possessed by them may thus be scarcely or not at all appreciated. For the full development of the sense of smell, it is necessary that the air be drawn in through the nose with sustained force, or in a succession of pretty powerful sniffs.

Voice and Speech.—Of all the attributes of the group of organs now under consideration, those of voice and speech are the most complicated, have the closest relations with all that is intellectual in us, and are in every point of view the most interesting. We proceed, therefore, to discuss them in some detail.

Before they can be understood it is necessary to have a knowledge of so much of acoustics as concerns them. And as we are bound to assume that most of our readers are more or less ignorant of this subject, we proceed to make some remarks upon it.

All sounds are caused by waves of alternate expansion and contraction, which, traversing air, or water, or solids (as the case may be), fall upon the drum of the ear, whence they are conveyed along the ossicles of the middle ear to the fluid contents of the internal ear, and thence to the specially arranged rootlets of the auditory nerves, which carry the acoustic impressions to the brain, where they become perceptions of sound. These waves are produced or determined by forces (for the most part acting with more or less suddenness or violence) exerted on the medium in which they originate; and they tend to travel more or less rapidly in widening circles in the same manner as the circling waves spread over the surface of water from the point at which it has been disturbed by a stone. Sounds are musical or unmusical.

Musical Sounds are the product of waves or undulations of uniform length, following one another at equal intervals, which are so short that the individual waves are undistinguishable by the ear as separate sounds, but blend acoustically into continuous notes. The varying characters of musical sounds depend on loudness or volume, pitch, and quality or timbre.

Loudness or volume has no relation to the length of the waves or to their form; but depends solely on their amplitude; that is, on their height if they be represented by the vibrations of a string; but on the intensity of the molecular movement if they be represented as waves of alternate condensation and expansion.

Pitch relates to the highness or lowness of the musical sounds, and depends wholly on the rapidity with which wave follows wave; or, in other words, on the length of waves in the same medium. Thus, the lowest audible note is composed of waves which follow one another at the rate of about sixteen in the second, and individually measure about sixty-four feet in length; whilst the highest audible note consists of waves following one another at the rate of about 38,000 in the second, of which each measures about one-third of an inch in length. Any note which is the octave above another consists of waves which are exactly twice as rapid and half as long as those of the latter; and of course, conversely, every note which is an octave below another is formed by waves of half the rapidity and twice the length of those due to the other note.

Quality of sound is determined by the form or complexity of the vibrations; but especially, perhaps, by the latter condition. Thus, in most musical sounds, the primary or fundamental waves, whose length and rate per second determine the notes, are overlaid, as it were, by a more or less complex series of subordinate waves, just as the larger waves on the surface of water are rippled over with groups of waves of smaller dimensions. But these subordinate waves (in the case of sound-waves), however numerous and various in amplitude they may be, are always aliquot parts of the larger waves; are always (for example) half, a quarter, one-eighth, one-sixteenth part of them, and so on, and thus blend harmoniously with them, mingling the higher notes due to themselves with the fundamental tones due to the primary vibrations. The secondary, or *harmonic* sounds, which mingle with the primary or *fundamental* notes, differ in number and individuality, and also in relative intensity in different cases. And it is due to differences in these superadded conditions that the same notes produced by different musical instruments, and by human voices, differ characteristically from one another.

Unmusical sounds or *noises* are due either to undulations, which are solitary, so that no musical quality can possibly attach to them; or they are produced by groups of vibrations which are of unequal length, and follow one another irregularly; or possibly of waves which (while of equal length) are irregular in volume and intensity. It should be added that not infrequently sounds which are unmusical in themselves are followed or attended by comparatively feeble resonances, which themselves are distinctly musical. This is exemplified in the specific sounds of consonants, and also in the sound of the footfall in a vault or between high walls.

Let us now return to the consideration of the organs of speech. The sounds of speech are made up of two distinct, though associated, elements—namely, first, the *voice*, or sounds (for the most part musical), produced in the larynx, at the *rima glottidis;* and, second, *articulate sounds*, which are essentially the product of the parts above the larynx, and mainly of the mouth, and to a large extent are engrafted on the laryngeal sounds.

Voice.—The larynx is a musical instrument of great beauty, and (within its limits) of great perfection; but while it is capable of evolving a fairly wide range of musical notes, it is wholly incapable of moulding them into articulate sounds. The music of the voice depends upon it alone. What is the nature of the instrument, and how does it act?

Musical instruments are of various kinds; but there are three varieties, to each of which it has been supposed to have some kind of relation—namely, first, the organ; second, stringed instruments; and third, reed instruments.

The *organ* consists of a series of pipes of different lengths, the vibrations of the air within which cause musical notes, the pitch of each of which is determined solely by the length of the pipe in which vibration is taking place. The longer the tubes the deeper the notes, and conversely. In this instrument the air is put into vibration by means of a tongue or reed inserted into the pipe, over which air is made to pass with more or less violence. The resemblance of the larynx to an organ-pipe is due to the association with it of the pipes of the trachea and larger bronchial tubes; the vocal cords representing the reed. But that it is really not an instrument of this nature is shown by the fact that, while an organ-pipe is capable of producing only one fundamental note—namely, that due to its length—the organ of the voice is capable of uttering all the notes embraced within two or three octaves, even though the tube associated with it undergoes no material change of dimension. Moreover, the deeper notes of the voice would need for their production a much longer tube than that of the trachea.

The relations of the larynx to a *stringed instrument* reside mainly in the fact that the voice is determined by the vibration of the vocal cords, which in the main obey the laws governing the vibration of strings. We need not go fully into these laws. There are two, however, which concern us now. One is, that the vibrations of strings, equally stretched, equally thick, and of the same density, vary in number in a given time inversely as their lengths. Thus, if we have three such strings, of which one is four feet long, the second two feet, and the third one foot, and we assume the first to yield 100 vibrations in the second; the next will yield 200 vibrations, and the last 400. The other law is that, assuming the length, thickness, and density of a string to remain unaltered, the number of vibrations which it yields in a given time are proportional to the square roots of the numbers representing the weights or forces by which they are stretched. Hence, if three such strings be rendered tense by forces represented by one pound, four pounds, and nine pounds respectively, the second string will vibrate twice as rapidly, and the third thrice as rapidly, as the first. A further principle relating to strings is that, while by the rate, duration, and intensity of their vibrations they determine the pitch, and to a great extent the quality and power of musical notes, they effect this result not directly by their own vibrations (which in themselves are almost voiceless), but mainly by evoking similar concurrent vibrations in some sound-board to which they are attached. But, in the case of the larynx (although no doubt the vibrations of the vocal cords determine the pitch, and some of the other properties of the notes of the voice) this is due in a very small degree, if at all, to excited vibrations in the solid walls of the organ, but essentially to the rhythmical transmission of air through the chink which the vocal cords bound. The larynx is, therefore, not a *stringed* instrument in the usual sense of that term.

The third class of instruments to which the larynx has been likened consists of those known as reed instruments, in which a tongue, free to vibrate in a narrow chink, is made to vibrate rhythmically by directing a blast of air upon it; its vibrations determining the rhythmical transmission of air in puffs through the chink, by which rhythmical puffs, and not by the tongue itself directly, nor by the solid material to which the tongue is attached, the musical note is produced. The essential difference, it may be remarked, between these instruments and organ-pipes (which are also wakened into sound by reeds) is this:—in the organ-pipe the reed merely causes a flutter which evokes the fundamental note of the pipe, in the true reed instrument the reed determines the note. It is clear that the larynx, if not a true reed instrument, has at any rate very special relations thereto.

Let us consider now, with particular reference to the above remarks, how the larynx acts in the production of sound. Whenever we are about to sing or speak aloud, the vocal cords are made more or less tense, and brought into close apposition; they touch one another in their whole length, and the space between them is obliterated. Then with more or less force, through the agency of the muscles of expiration, we drive the air accumulated in the lungs outwards along the bronchial tubes and trachea to the larynx, and through the *rima glottidis,* whence it passes onwards to the nose and mouth. The forcible transmission of air between the closely approximated and tense vocal cords throws these latter into synchronous vibration, and determines the passage of the air, not in a continuous stream, but in a series of jets or puffs, which correspond in frequency to their vibrations. These puffs are ample or the reverse, according as the vibrations of the cords are ample or the reverse; and have impressed upon them all those varieties of form due to the presence of secondary undulations or harmonics, which attend the vibrations of the cords themselves. So far it is clear we have a reed instrument to deal with; but it is a reed instrument, in which in place of a vibrating tongue placed within a narrow chink we have two vibrating tongues or bands bounding such an orifice. The chief peculiarity of the reed here, however, is, that in the main it obeys the laws of strings, and determines the notes of the voice in accordance with these laws.

The principal cause of the varying notes of the voice is the varying tension of the cords in length, determined, as we have already shown, by the vertical rotation of the thyroid cartilage on the cricoid cartilage, and the consequent approximation or separation of the anterior and posterior attachments of the cords. When the cords are shortened and relaxed their vibrations are relatively few in number, and the notes are consequently deep; when they are elongated and tense their vibrations are relatively rapid, and the notes are consequently high. The law which mainly governs the vocal functions of the cords is the second of the laws previously quoted with respect to the vibrations of strings (namely, that in strings of the same thickness, density, and length, the numbers of vibrations yielded in a given time vary directly as the square roots of the stretching forces)—a law the exercise of which allows of the production of a wide range of sounds from strings of small dimensions. But the vibrations of the cords are not dependent wholly on the operation of this law, for the cords vary in length with the variations in the force which acts upon them, and at the same time become thicker or thinner, as the case may be. Hence, as they are relatively short when the force tending to elongate them is acting feebly; and as cords of low tension vibrate less rapidly than cords of high tension, while short cords (other things being equal) vibrate more rapidly than long cords, the tendency to slow vibration due to the former condition is modified by the tendency to rapid vibration due to the latter condition. And so, conversely, the cords become relatively long when they are forcibly pulled, so that the numbers of vibrations due to the increase of tension become diminished from the effects of their increased length. It is, nevertheless, certain that the various notes of the voice are determined essentially by variations in tension, and that the differences of length and of thickness modify the action of the law of tension only in a very slight degree.

The *Compass* of the voice, that is the range of musical notes which it can evolve, varies, in different persons, from one to three octaves, and its collective total range is about four octaves. The voices of men extend about an octave lower in the scale than those of women. But, on the other hand, women's voices reach about an octave higher than men's. The difference between the sexes in this respect is due to the fact that in men the larynx is larger than in women, and the vocal cords are longer. There are two principal varieties of voice in men—namely, the bass and the tenor; and two principal varieties in women—namely, the contralto and the soprano. The *bass* is the lowest male voice, and its strength lies in the lowest notes. The *tenor* extends higher than the bass, but not so low. The *contralto* is the lowest female voice; the *soprano* the highest. It must be borne in mind, however, that these several voices may all be capable of uttering certain notes in common, and that even the higher voices may be able to produce notes low in the scale, and conversely. Essential distinctions between them are, that the strongest notes of each variety occupy a particular part of the scale, and that they present marked differences of quality or timbre.

Children's voices are higher than those of adults in consequence of the comparatively small size of their vocal organs; and even at this early period there is a marked difference in quality between the voices of males and females. Young boys' voices have a close resemblance to women's voices. In both sexes there is a change in the voice about the time of puberty; but, while in the girl this is slight and gradual, and occurs without any hitch, in the male the change of the child's voice into that of the man is attended with remarkable phenomena. In the latter case the conversion of the childish treble into the deep tones of the adult, which depends on a rapid and characteristic development of the larynx, is marked by a transition period in which the voice becomes husky and uncertain, and apt to utter grave and high notes indiscriminately.

The remarks above made refer to the *natural* or *chest voice* alone. It is well known, however, that singers, and men in greater proportion and in greater degree than women, are capable of uttering two series of vocal sounds—one, the natural voice, which is produced with comparatively little effort; the other, a higher and thinner voice (termed the *falsetto*), which is evolved with comparative difficulty and sense of effort or constriction about the throat, some notes of which overlap the notes of the natural register, and which, as a general rule, does not amalgamate readily with the natural voice. Different explanations have been given by physiologists of the falsetto voice. There is reason, however, to believe, with Helmholtz, that through the agency of muscular fibres which are attached to the outer sides of the vocal cords, these may be rendered thinner at the extreme edges, and that the vibrations occurring in these edges produce notes of different quality from those due to the vibration of the cords in their whole thickness.

Another variety of voice is the *whispered voice.* In this there is no musical sound whatever, and indeed, if while whispering the *rima glottidis* be examined by means of the laryngoscope, it will be found partly open, and the conditions necessary for the production of musical sounds absent. The breath, in fact, in whispering, is made to escape with a kind of breezy sound through the partly open glottis. A somewhat similar sound is caused, in the same manner, during yawning or sighing, or whenever respiration is deep or rapid.

Articulate Sounds, which are the essential factors of speech, are effected mainly in the cavities above the *rima glottidis*, the mouth taking the principal share in their production. The proper sounds of the letters constitute the elementary sounds. And it is by the grouping of these letters in various combinations that words are formed. Words are practically innumerable ; but literal sounds are comparatively few.

Let us first consider the varieties which these sounds present and their mode of production.

The *Letters of our Alphabet* are twenty-six in number, of which five are regarded as vowels, and the remaining twenty-one, with, perhaps, one or two exceptions, as consonants. Our alphabet, however, is imperfect in many respects. In the first place, many of the names applied to the letters are mere names, having little or no phonetic relation to the sounds they represent. In the second place, several letters are superfluous, standing (like j, q, x) for a combination of simple letters, or (like c) having two sounds, of which each is also represented by another letter. In the third place, many letters represent indifferently several distinct literal sounds. This is the case with all of the vowels, and with several of the consonants, such as s, z, g, and y. And, lastly, there are several literal sounds for which we have no letter-characters, and which are indicated in practice by letters, or combinations of letters, which represent them conventionally only. Among the consonants unrepresented by proper characters are the *ng* in *tongue*, the *th* in *this*, and the *th* in *thing*, the *sh* in *she*, the *z* in *azure*, and the German *ch* in *ich*, and as sounded also at the beginning of the word *Hugh*.

Vowels are sounds which are capable of being uttered continuously without alteration of quality ; they are the sounds which, with very few exceptions, are employed to give force to consonants, and to blend them into syllables, and they are the vocal sounds which in singing carry the music of the singer's voice. Their fundamental sound is the product of the larynx, and may be any note which the larynx is capable of uttering, or the mere breezy sound which characterises a whisper. In these respects the vowels are all alike and undistinguishable. Their mutually distinctive qualities are acquired in the throat and mouth, and (in the case of the French nasal vowels) in the nose, and are determined by differences of form which these cavities and their inlets and outlets are made to assume—differences of form which are special for each vowel-sound. It is an essential characteristic of vowels, however, that in their utterance there is a free channel for the continuous passage of air along the fauces and mouth, and between the lips.

The vowel-sounds in English are probably thirteen in number, and are represented in the vowel-sounds comprised in the following words : *far*, *fal*(low), *fell*, *fail*, *fill*, *feel*, *fur*(rier), *fur*, *fol*(ly), *fall*, *foal*, *full*, and *fool*. And they may be arranged in three groups determined by the positions which the organs of articulation assume in their enunciation.

The vowels of the first series are the first six in the above list. They seem related to one another, not only in sound, but because in their utterance the lips are separated from one another in their whole extent ; and the differences between them appear to depend partly on the fact that in enunciating them in their order, from the first to the last, the orifice between the lips tends to become progressively narrower, but mainly on the fact that the tongue, which is much depressed and retracted in the utterance of *a* (in *far*), becomes progressively more and more elevated and projected forwards in the utterance of the others, until, in the pronunciation of *e*, the dorsum of the tongue leaves only a narrow channel between it and the palate, and the tip approaches within half an inch of the lower incisor teeth.

The vowels of the second series are *u* in *fur*(rier) and *u* in *fur*. In articulating these the mouth is maintained slightly open, without effort, as it commonly is in ordinary quiet breathing, and the tongue, similarly at rest, lies on the floor of the mouth. These, in fact, are the easiest vowel-sounds to pronounce, and are the most common.

The last series comprises the remaining five enumerated vowels. There is a manifest relationship between them in sound, and in the fact that in pronouncing each of them the oral aperture assumes a rounded form. The size of this orifice becomes smaller and smaller as we proceed from the first to the last ; and, as in the first series, the tongue, which is depressed and retracted in uttering the first, rises towards the palate and approaches the front teeth as the remainder of the series are in turn pronounced.

The above brief discussion merely shows that for the enunciation of each letter a particular arrangement of the organs of articulation has to be effected ; but it does not explain, or even hint, how it is that by such various arrangements we produce series of sounds which the ear distinguishes from one another with the utmost facility. The explanation of this phenomenon is that which was suggested by Wheatstone many years ago, and has more recently been put beyond dispute by Helmholtz. It is that the vowel-sounds differ from one another in the number, individuality, and intensity of the harmonics which cluster, as it were, around the sound emitted by the larynx, and that these are determined by the special resonating qualities which the oral and faucial canal presents, in the several varieties of capacity and form which belong to the utterance of the several vowel-sounds.

The Consonants are distinguished from the vowels mainly by the facts that more complete barriers are opposed in the articulatory organs to the passage of the breath than occurs when vowels are sounded, and that they are, in their mutually distinctive characters (which are effected above the larynx), clicks or noises which are distinctly unmusical.

Consonants admit of arrangement in several more or less natural groups. We shall not enter on this difficult subject at length or minutely, but shall endeavour to give such an account of them as may be generally intelligible. First, then, we have the consonants in pronouncing which the obstruction or barrier exists at the lips, or is formed by the lips and teeth: these are b, p, m, v, f, and w, and are termed *labials.* Next we have those in which the barrier is formed by the margin of the tongue and teeth: these, the *linguals,* are d, t, n, th in *this,* th in *thing,* s, z in *gaze,* r, l, sh in *she,* and z in *azure.* And, lastly, we have the *gutturals,* in which the barrier is formed by the approximation of the soft palate and base of the tongue. The chief of these are hard g and k, ng in *tongue,* y in *youth,* and the German ch in *ich,* or the first sound in such words as *Hugh* and *Whewell.*

In the next place, we may divide the consonants into those which are *explosive* and those which are, like vowels, *continuous.* The former are only of momentary duration, and developed at the time either of closing a barrier or of opening it. These are b, p, d, t, hard g, and k. In forming the others the barriers are at all times imperfectly closed, and the specific sound is produced while the air is fluttering, or streaming past the barrier. All the remaining consonants belong to this category. It is observable that these have all somewhat of the vowel character, that tunes may be hummed with them, and that not infrequently they take the place of vowels in the formation of syllables. The last syllable of "maiden" and "little" are examples, for the written e in either case is unsounded.

Again, consonants may be distinguished as *oral* and *nasal.* The latter are m, n, and ng, in pronouncing which the oral barrier is perfectly closed, but the communication between the fauces and nose remains open, so that the breath, during their utterance, escapes through the nostrils. In regard to all other consonants, the soft palate comes into relation with the posterior wall of the pharynx, and the nasal cavity is completely cut off from the parts below.

Lastly, consonants are divisible into those which are *voiced* or *sonant,* and those which are *voiceless* or *surd.* In the former series the consonantal sound is engrafted (as are the vowel-sounds) on vocal or laryngeal sound; in the pronunciation of the latter the *rima glottidis* is open, no laryngeal sound whatever occurs, and the consonantal sound is the simple, uncomplicated product of the mouth. The vocal consonants are b, v, m, w, d, th in *this,* n, z in *gaze,* r, l, ż in *azure,* hard g and y. The unvocal consonants are p, f, t, th in *thing,* s, sh in *she,* k, and the German ch. It may be observed that, in naming them, all consonants are associated with voiced or sonant vowels, and that, in determining whether consonants are voiced or not, they must be pronounced apart from vowel-sounds.

We have pointed out what is the scientific explanation of the acoustic differences between the different vowels. What is the scientific explanation of the acoustic differences between the different consonants? The explanation is much of the same kind in both cases; only, as respects the consonants, the fundamental sound, or that which determines the character of the consonant, is effected at that point in the mouth or throat at which the barrier or obstruction exists. Thus, the fundamental sound of b or p is produced at the lips at the moment of making or breaking contact, and the fundamental sound of d or t is produced in the same way, between the tip of the tongue and the anterior part of the palate, just above the front teeth. Now, in each of these cases the fundamental sound is a mere click or crack, something like the crack of a whip, momentary in duration, and wholly without musical character; and if the lips had not the cavity of the mouth behind them, or if the tip of the tongue had not a cavity in front and one also behind, the sound produced would be a mere click, and have no literal characteristic whatever. The clicks, in fact, derive their distinctive literal qualities from the fact that they are produced in relation with cavities wherein they evoke musical resonances which, blending with the fundamental sounds, convert them into letters. In b and p the resonance takes place in the general oral cavity, in d and t it takes place in the two differently sized portions into which the tongue divides this cavity. The differences between m and b, and n and d respectively, are (in addition to the continuous character of the nasal sounds) that in sounding m and n, the nose retaining its continuity with the fauces allows resonances also to take place in the nasal cavity, which blend with those occurring in the mouth. The above remarks have had reference chiefly to the explosive consonants. But the continuous oral consonants admit of a similar explanation. The essential sound in each case is produced by a kind of unmusical flutter developed during the passage of breath past or through the barrier, and the superadded oral resonances (determined as to quality by the various forms and sizes which the internal parts of the mouth assume for each case) give the consonants their distinctive characters.

A word or two may here be added with reference to the so-called consonant *h*. This is generally regarded as a simple unvocalised rush of air through the glottis opened widely. This, however, does not correctly convey its real character. It is, no doubt, an unvocalised sound; but the air which comes noiselessly from the larynx acquires sound in the mouth, through which it is forcibly driven. And a little examination will show that, in uttering it before any vowel or any consonant which admits of a preceding aspirate, the mouth assumes the form of the letter which it precedes; and that, in fact, in every case, it is the surd or voiceless equivalent of the sonant vowel or consonant in conjunction with which it is pronounced.

FUNCTIONAL DERANGEMENTS.

The effects of disease, apart from the local processes (such as inflammation, the growth of tumours, and degeneration or destruction of tissue) which accompany it and indicate its presence, are essentially exaltation of function, impairment of function, and perversion of function. Let us consider what are the functional disturbances which characterise affections of the organs now under consideration.

And first, as regards the mucous membrane. The duties which this has to perform are—to act as an organ of common sensation, to minister to the special senses of smell and taste, to secrete a protective mucus which lubricates the surface, and itself to protect the parts that lie beneath it.

Common sensation exists throughout the whole of the ori-nasal surface, and throughout that of the fauces, pharynx, and larynx. It depends on the abundant distribution to these parts of sensory nerves derived from the base of the brain, and through this brought into relation with the perceptive portions of the surface of the brain. It varies, no doubt, in quality in different regions, and serves partly to protect the organs from injury, partly to guide them in their actions. Thus the tactile sensibility of the nose readily recognises degrees of temperature; it is through it that the nose resents the intrusion of irritant gases such as ammonia or sal volatile, and it is through muscular co-ordinations brought into play by irritation of this surface that sneezing is produced—a violent spasmodic expiratory action, in which the blast of air from the air-passages is directed mainly through the nose for the purpose of expelling offending matters within it. The sensibility of the mouth, which is peculiarly developed in the lips and tip of the tongue, is partly of service in determining whether matters taken into the mouth are hurtful through their hardness, or angularity, or temperature, or chemical attributes, but mainly by guiding us in the movements of our lips, and tongue, and cheeks, in the complicated movements connected with mastication. The sensibility of the fauces and pharynx is mainly instrumental in evoking the automatic phenomena of deglutition, or swallowing, actions over which the will has no direct control. It is this same kind of sense which compels the soft palate, in swallowing, to guard the posterior entrance to the nose, and the laryngeal muscles to close the glottis. The sensibility of the larynx and windpipe is protective against the entrance of offending matters, and, under the influence of irritation, causes the protective act of coughing.

In disease these sensory functions are sometimes exalted; influences which in health would have had no effect, or very little, now provoke unwonted sensory impressions, or evoke in an extreme degree spasmodic movements such as sneezing, constriction of the pharynx, and closure of the glottis. Sometimes they are impaired or annulled. Sometimes they are perverted, and the patient suffers from neuralgia, or some other form of uneasy sensation.

Similar observations may be made as regards the special senses of taste and smell. These may be rendered over-sensitive, and impressions that would have been agreeable or scarcely noticeable in the normal state now become disagreeable, painful, or unbearable. They may undergo diminution or be destroyed; or they may become perverted; and, moreover, the patient may suffer from what is equivalent to neuralgia in the nerves of common sensation—namely, subjective sensations of smell or taste; or, in other words, he may experience smells or tastes (for the most part disagreeable ones) which are not due to the action of sapid or odorous substances, but which take their origin in some affection of the gustatory or olfactory nerves.

The several phenomena above enumerated may be due to various causes. Thus, they may be a consequence of morbid changes taking place in the mucous membrane itself, and in the nerves which are included in the mucous membrane; or they may be a consequence of affections of the nerve-trunks which are the carriers of impressions to the brain; or they may be determined by morbid conditions of the substance of the brain itself. It may be observed that when the cause of the symptoms is some affection of the mucous membrane, this generally manifests changes visible to the naked eye which are sufficient to explain them ; that when it resides in a nerve-trunk the symptoms are limited to the area of distribution of the nerve, and are consequently unilateral, and stop short at the median plane of the body ; and that when it resides in the brain itself it is sometimes unilateral, but occasionally general, and, associated with the phenomena due to the parts in question, we generally have similar affection of the nerves of various other regions of the body.

The secretion of mucus in health is only sufficient to keep the surfaces moist. In disease the mucus may be augmented in quantity, it may undergo diminution, or its quality may be altered. All these phenomena are well exemplified in the course of an ordinary catarrh of the nose. In the first instance, the mucous membrane becomes swollen and dry ; later the secretion becomes re-established, but it is now formed in excess ; and, further, it is materially altered in character—at one time being thinner and more watery than true mucus should be, and irritating to the parts over which it flows, at another time being thick, opaque, and ropy. But the secretions of the mouth are not wholly or even chiefly mucus, for three pairs of salivary glands are constantly pouring their specific secretions into the cavity of the mouth, where they mingle with the mucus, and aid importantly in the mastication and reduction of the food. These, again, are liable in disease to be modified in each of the three ways above indicated.

The acts of prehension, mastication, and swallowing, demand for their perfect performance the integrity of all the organs concerned in the process. For the division of solid food and its reduction to a pulp, not only must the teeth be in good condition, but the muscles which open and close the jaws, and those which make the lower jaw rotate horizontally on the upper jaw, must retain their inherent strength, and the nerves which convey the behests to them from above must also be in working order. Further, in order to retain the food within the mouth the lips must be capable of closure, and the muscles of the cheeks must be able to co-operate with the tongue in retaining the food between the teeth, and, finally, in placing the food on the dorsum of the tongue preparatory to its being swallowed. And again, in order that the act of swallowing may be effected easily and without hitch, the base of the tongue, the pillars of the fauces, and the other muscular walls which co-operate in the process, must be in condition to act in unison and with promptness. Lastly, it must be pointed out that the sensory attributes of the mucous surface constitute an essential factor in the performance of these duties. If the lips do not feel, they can scarcely act efficiently in retaining food within the mouth. If the tongue and cheeks be without sensation, the presence of food in the mouth would not be recognised, and it is scarcely possible that it should be " manipulated " with dexterity. And if the fauces and pharynx be devoid of sensation, or rather, perhaps, be devoid of that sensibility which determines reflex action, the act of swallowing—which is a purely reflex phenomenon, and wholly independent of voluntary effort—would become impossible.

The circumstances which interfere with the due performance of the above functions are numerous, and their modes of operation are widely different. If the lips, or gums, or cheeks, or tongue, be inflamed or sore, or the seat of morbid growth, it is clear that the uneasiness or pain attending mastication will interfere more or less with its effectual performance. If the salivary and other secretions be scanty, and the mouth therefore dry, solid food will be difficult to deal with; it will crumble, will be incapable of being collected into a coherent mass, and will be difficult both of being brought within the influence of the teeth and of being formed into a bolus suitable for swallowing. If the teeth be absent or defective, the due comminution of the food becomes a matter of difficulty, or even impossibility; and, again, the duties which should be effected within the mouth are inefficiently performed.

The most serious difficulties which interfere with the duties of the mouth, in relation to the digestive functions, are those which are referable to the nerves of sensation or motion, or of the nervous centres with which these nerves are in relation.

As before pointed out, when nerves alone are affected the resulting paralysis or spasm is, for the most part, unilateral or one-sided. The particular affections of this kind, which are generally met with, are paralysis of the nerve which supplies the muscles of expression; paralysis of the nerve which is the medium of common sensation for the face, nose, and mouth, but which also is the motor nerve of the proper muscles of mastication; and paralysis of the nerve which governs the movements of the tongue.

The first of these nerves is the motor nerve of the muscles which move the lips, and also of that which, extending in the form of a sheet from the upper to the lower jaw, constitutes an essential part of the cheek. The effects of paralysis of these special parts are, first, as regards the lips, that they are pulled towards the healthy side in consequence of the unopposed action of the muscles on that side, that the mouth is neither opened so widely nor closed so firmly on the affected side as on the other, and that food and saliva, and more especially fluids, are imperfectly retained; and, second, as regards the cheek, that this becomes flaccid, and having, consequently, no power to contract on the food which finds its way into the pouch between it and the teeth, permits of the passive accumulation of the food there until, probably, it has to be dislodged by the finger.

The second of the nerves above referred to supplies sensory fibres to the whole of the side of the face from above downwards, and also to the interior of the mouth and nose on the corresponding side. When this, therefore, is affected—to speak only of the mouth—one-half of the lips, one-half of the tongue, and one-half of the interior of the cheek and gums, up to the median plane of the body, are wholly devoid of feeling. The cup, when taken between the lips, feels broken at the point where sensation ceases, and neither touching, nor cutting, nor burning is perceived upon the affected side. Consequently, although the muscular powers may be fully retained, the inability to appreciate what is required of them renders them as useless as if they were paralysed; and consequently, as in the former case, the food is apt to fall from the mouth, or to collect in the pouch between the teeth and cheek. If, at the same time, the special muscles of mastication be involved, the preponderating action of those on the other side causes lateral displacement of the lower jaw during mastication, and impairs the efficiency of the act of chewing.

Paralysis of one-half of the tongue is attended with less inconvenience than might be supposed. In protruding the organ its tip is made to incline to the sound side, owing to its active side overcoming its passive side in the process; and in drawing it back again, the converse phenomenon occurs. Mastication and deglutition, however, are but little interfered with.

In one-sided paralysis of the body (or hemiplegia, as it is called) incomplete paralysis affects the voluntary muscles of one side of the face, tongue, and mouth. The lips, the tongue, the cheek, and the muscles of mastication, are equally affected. But it is an interesting fact that the muscles over which the will has no special control, and those which cannot by voluntary effort be dissevered in action from those of the opposite side, do not share (or share almost imperceptibly) in the paralysis. Hence the muscular walls of the fauces and those of the pharynx escape; so that, while there may be a little difficulty in prehension and mastication, there is none in swallowing.

But paralysis of cerebral origin is occasionally of irregular distribution, or affects both sides equally. One variety of this is observed in general paralysis of the insane. Another variety is that sometimes called bulbar paralysis, where the damage on which it depends is seated in that part of the base of the brain which is the immediate source of most of the motor and sensory nerves of the head and face. A third variety is that which so often follows on diphtheria, during the period of convalescence. In the first case the patient loses, for the most part in equal proportion, smell and taste, common sensation, and the power of motion, and has (as the consequence of the last condition) progressive loss of power of mastication and swallowing, and finally is likely to die choked. In the second case the progress of the disease is, for the most part, unattended with any mental impairment. Taste and feeling are rarely lost. But as the disease develops, the lips become large, loose, and pendulous, incapable of complete closure, and requiring, perhaps, to be brought together by the hand when the upper one has been largely elevated in the act of laughing; the tongue becomes large and flabby, and lies almost motionless on the floor of the mouth; the soft palate and fauces lose power; and, as a consequence of these conditions, saliva drips from the mouth and accumulates in the oral cavity, mastication becomes almost impracticable, and the paralysis of the tongue makes it difficult or impossible to carry food by its aid from the mouth to the fauces, so as to inaugurate the act of swallowing. Moreover, when the food reaches this part (having either been pushed on by the finger or allowed to fall there by throwing the head back) it is swallowed with difficulty, and not infrequently finds its way into the nose or goes down the "wrong way." In diphtheria the paralysis is symmetrical and, for the most part, evanescent, and sensation and motion are both liable to suffer. The paralysis is apt to be more or less widely distributed; but, so far as the organs under consideration are concerned, there may be loss of feeling in the lips or tip of the tongue, but the motor paralysis is usually limited to the throat, and is consequently indicated by difficulty of swallowing and the entrance of food into the nose and windpipe.

But besides paralytic affections we meet with the (in some sense) converse condition of spasm. Amongst the most interesting and important varieties of spasms may be enumerated those of chorea or St. Vitus's dance, those of tetanus, and those of hydrophobia. In the first case the lips and tongue generally share in the odd fidgety movements which characterise the disease, and the presence of these movements sometimes interferes seriously with mastication and deglutition. In tetanus, or lock-jaw, one of the most striking features of the disease is the more or less persistent spasmodic closure of the jaws, liable, however, to more or less frequent increase of spasm, which is attended with painful cramps in the muscles, and prevents in large degree the administration of food. In hydrophobia the spasm affects mainly the throat, and in the height of the disease is not only brought on by any attempt to swallow fluids, but even by the sight or sound of water, or by a breath of air.

Affections of Respiration.

By far the most interesting affections concerning the mouth and throat are those which involve respiration, voice, and speech; and these we now proceed to discuss.

The function of respiration suffers in a greater or less degree in a large number of affections, most of which are beyond the sphere of our present investigations. Respiratory troubles due to affections of the nose, mouth, and throat, are likely to be more severe as we pass from above downwards, and necessarily culminate in affections of the larynx itself.

The symptoms which indicate impediment to respiration vary in their intensity and also in the rapidity with which they are developed. But essentially they are those of asphyxia, or symptoms depending on the poisonous effects of carbonic acid (which should be thrown off during respiration) retained in the blood.

The purposes of respiration are: first, the furnishing of the oxygen of the atmosphere to the blood, for the purpose of destroying effete matters by slow combustion, and maintaining the animal temperature; and, second, the elimination of carbonic acid, one of the chief products of this combustion, which accumulates in the venous blood, and is a virulent poison. Now, when respiration is impeded the due amount of oxygen does not enter the blood, and the due amount of carbonic acid does not escape from it; and the consequence is that the venous blood, remaining unpurified or imperfectly purified in the lungs, passes thence into the arteries still as venous or dark blood, and, with the persistence of impediment, the blood becomes darker and darker.

The immediate effects of the poisoned blood are exerted mainly on the circulatory organs and nervous system. As regards the organs of circulation, we observe that very soon the altered blood finds its way with difficulty through the small vessels of the lungs, and that consequently, while the left side of the heart becomes starved (so to speak) of blood, the right becomes overloaded; and, as a later consequence, that, while the arteries become empty, the veins and capillary vessels become distended; and that, depending on these conditions, the pulse becomes feebler and feebler, the visible veins appear enlarged, the general surface grows more or less leaden-coloured, or livid (especially those parts of it which are naturally rosy) and swollen, and the temperature tends to fall. As regards the nervous system, we observe that the patient complains of headache and noises in the ears, and that he tends gradually to ramble in his mind, and ultimately to become comatose or insensible. But, associated with the symptoms above detailed, we have other symptoms which are referable to the exaggeration of that instinctive sense and impulse on which the due performance of our respiratory actions in health depend. In the presence of any serious and persistent impediment, the sense of want of breath increases to agony; and the acts of respiration become almost frantic in their violence. The patient opens his mouth widely; the ordinary muscles which move the chest act with violence; and additionally other muscles, which have only an indirect influence over the movements of respiration, are called into play. The patient, moreover, has probably to sit up in bed, or to rise to the standing position, and to clutch at things above his head, in order to give his powerfully-working muscles due leverage.

The symptoms of dyspnœa are the same essentially, whether the impediment be slight or severe, whether it be acute in its development, or of slow progress. If, however, it be slight, it may well be (in some cases at any rate) that increased respiratory efforts succeed in ensuring the due supply of oxygen, and the due discharge of carbonic acid; and the symptoms of carbonic acid poisoning consequently do not arise. If it be of slow development, the respiratory actions may never be exceedingly violent; and the consequences of carbonic acid poisoning may be fully developed only after the lapse of some weeks or months. Under these circumstances phenomena which have not time to appear in rapid asphyxia gradually arise: these being mainly dilatation of the right side of the heart, permanent enlargement of the veins, general dropsy, and the results of long-continued congestion of certain internal organs. The tendency to loss of temperature, also, is more marked in these cases than in others.

In rapidly fatal asphyxia, as in drowning or strangling, or even as in acute inflammatory affections of the larynx, the phenomena of asphyxia arise rapidly, and the symptoms, which are terrible to witness and painful to suffer, speedily culminate in coma or insensibility and death.

In connection with the subject of dyspnœa we may draw attention to the process by which irritations or impediments seated in the strictly respiratory passages—namely, the larynx, trachea, and bronchial tubes—are removed or attempted to be removed for the most part automatically: we mean the act of *coughing.* This effects for the true respiratory passages what sneezing effects for the nose. Ordinarily the steps of the process of coughing are as follows:—1st, a deep breath is drawn; 2nd, the laryngeal orifice is tightly occluded by the juxtaposition of the vocal cords; and 3rd, the muscles of expiration, by a sudden violent and combined effort, discharge the accumulated air in the lungs along the air-passages and through the glottis, which itself spasmodically opposes the escape of air. The air is expelled with much violence, and carries with it such offending matters as are capable of dislodgment.

Coughs, however, vary in character. In some cases, as in the early stage of hooping-cough, they are incessant, hacking, and, for the most part, dry. In some, as in the later and characteristic stage of the same disease, they are spasmodic in a special sense: the patient is seized with a sudden propensity to cough, which is continued by a succession of more or less noisy expiratory shocks, without any intervening inspirations, until all the available air is expelled from the chest, and the patient is livid in the face, and possibly even becomes insensible; when suddenly he draws a deep and prolonged inspiration through the still contracted glottis, with a prolonged sound (a whistle or whoop), which gives its name to the disease. Not infrequently prolonged coughs lead to irritation of the fauces and pharynx, and this induces (again, as in hooping-cough) vomiting.

The noise which attends the shocks of coughing will be readily understood from the above account. It is effected mainly, as are vocal sounds, by the forcible emission of air between the closed and tense vocal cords; and the variations which it presents depend upon the presence of modifying causes. If the blast be strong, the sound produced (other things being equal) will be strong also. If it be feeble, we may expect the sound to be weak. It is generally loud and brassy when the vocal cords are modified in character by inflammatory changes; and, on the other hand, it is apt to be voiceless and wheezy when inflammatory products or diphtheritic membranes invest the vocal organs and narrow the channel for the escape of air. Hysterical coughs, which are by no means rare, are often loud and barking.

AFFECTIONS OF THE VOICE.

The voice, apart from articulation, is (as we have shown) effected essentially at the *rima glottidis.* It is there alone that its pitch and loudness are determined; and it is there, mainly, that it derives the timbre or quality by which we recognise the voice as being that of one person or another. Other harmonics, however, are added above the glottis, which, mingling with the voice as it is emitted from that part, tend, in a greater or less degree, to modify its quality as it escapes from the mouth.

Now, any affection of the throat which interferes with its normal condition influences the character of the voice. If the throat be inflamed, and stiff and swollen, and especially if the tonsils be enlarged, and the faucial passages consequently contracted, the voice acquires a peculiar character which is extremely difficult to describe, but which all persons probably have recognised in some one or other of their acquaintances. If the soft palate be paralysed or partly destroyed, or if a communication exist through the hard palate between the nose and mouth, the voice acquires a snuffling, nasal character, which again is well-marked and commonly appreciated.

Affections of the larynx itself are far more frequent causes of modification of the voice. Such affections are mainly inflammation; diseases which are attended with specific implication of the vocal cords (such as diphtheria, small-pox, and leprosy); morbid growths (such as cancer, tubercle, and lupus); and affections due to paralysis, or spasm.

In inflammation the vocal cords become thickened and softened, and are apt to be studded with adherent flakes of mucus. It is natural, therefore, that the voice should be rendered rough and hoarse, that its range should become contracted and the high notes especially should fail, and that its utterances should be uncertain. It is often louder and harsher than natural in the early stages; but, later, it tends to become weak and husky, and occasionally to be reduced to a mere whisper. In diphtheria and other cases in which the cords become invested in copious exudation, the voice naturally before long fails, and the patient becomes aphonic.

Similar phenomena occur in most of the other affections above enumerated; but the permanent mischief, which always results from such affections as cancer, tubercle, leprosy, lupus, and the like, necessarily leads before long to permanent impairment and ultimate loss of voice.

Paralytic Affections of Voice.—The most interesting modifications of the voice, however, are those which occur in connection with paralytic and other nervous disorders. Of these, many varieties are recognised and described by those who have paid special attention to the subject. There are two or three only to which we need refer.

The nerves which minister to the movements of the larynx are the pneumogastric nerves, derived from the medulla oblongata. Each of these gives off two branches to supply the corresponding half of the larynx. The upper branch is the nerve of sensation, and supplies motor fibres to one or two muscles. The lower branch is the main motor nerve, and supplies nearly all the laryngeal muscles. Now, any disease destroying or obstructing one of the pneumogastric nerves causes complete sensory and motor paralysis of the half of the larynx on the same side; and any similar affection of either of the special laryngeal nerves causes paralysis of the parts included in the area of its distribution. It is a curious fact, however, that that branch of the left pneumogastric which especially supplies the muscles is the nerve which, above all others, is liable to be involved in disease. This nerve takes a peculiar course: running down from the point at which it is given off from its trunk in the neck, it dips into the upper part of the chest, winds round the transverse arch of the aorta (the arterial trunk which comes direct from the heart), and, retracing its steps, ascends in the neck between the windpipe and the gullet, until it reaches the laryngeal muscles, to which it is distributed. In this long and tortuous course it is exposed to two main dangers. In the first place, if dilatation or aneurism of the transverse aortic arch takes place (and this is a frequent seat of aneurism), the nerve becomes stretched or compressed, and at length destroyed; and, in the second place, if the gullet be the seat of cancer (and this is a not uncommon disease), the morbid growth is apt to implicate the nerve. In both of these cases the left vocal cord becomes paralysed in its movements and stationary: a condition which reveals itself symptomatically by hoarseness or loss of voice, and can be recognised by inspection of the larynx by the laryngoscope. This paralysis is one of the most striking and important symptoms of these diseases, and is very often one of the earliest indications of the formation of an aneurism.

Diphtheria and hysteria are apt to cause paralysis of the vocal cords. But in these cases the paralysis involves both cords equally, is transient, or at any rate remediable, and is for the most part incomplete. In diphtheria it follows on affection of the throat, and is associated with the other characteristic paralyses of diphtheria. In hysteria, the loss of voice (which is often in the first instance induced by a cold, or by a mental shock) is usually associated with other more striking symptoms of hysteria. Moreover, the patient under excitement, or under the influence of a locally applied electric shock, may often be made (notwithstanding her paralysis), to call out at the top of her voice.

Another cause of nervous aphonia is chorea or St. Vitus's dance. In this disease there is often manifest difficulty of speech, the words coming out spasmodically. But occasionally complete aphonia, lasting for some time, may be observed. This is probably due rather to spasm than to paralysis.

The effects of age, of practice, and of abuse of the voice, are other subjects of interest, and in many respects of much practical importance.

We have already shown that the voice, in pitch, in quality, and in power, differs in the two sexes, and in the periods of life anterior to and succeeding puberty. The voice also undergoes changes with advancing life. This is particularly noticeable in the case of singers, who, sooner or later, suffer impairment not only of quality and power, but also (and very markedly) of compass. The extreme, and especially the higher, notes in the register are lost soonest. But what occurs in them occurs also, in a greater or less degree, in all persons. Further, in old age, the voice, from feebleness and uncertainty in the use of the respiratory organs, very often becomes tremulous.

By education, as is well known, not only may the voice be improved in strength and quality; but, within certain limits, the facility may be acquired of producing notes both higher and lower than those which the voice in its uneducated state could utter. Education also effects other improvements which are important not only for the singer, but for the speaker. Such are, economy in the use of the breath in phonation, the art of managing inspiration, so as not only never to get out of breath when speaking or singing, but to draw the breath in at moments when it least interferes with utterance, and the art of allowing the freest escape of vocalised breath through the fauces and mouth. Untaught singers and speakers not only tend to constrict the throat, but often phonate with insufficiently separated teeth and lips: faults which impair the resonance and quality of the voice, and render it indistinct.

It need scarcely be said that the application of the voice to singing demands something more than simple perfection of the mechanism by which vocal sounds are produced. The due use of the voice for this purpose requires the presence of the mental faculty of appreciating the relations of musical sounds to one another, and those combinations of them which are beautiful and pleasure-giving. Without the possession of a so-called "ear," the most beautiful and flexible voice will fail to produce music. With its possession, the harshest and most unpromising may be educated to some degree of musical utterance. There are few persons, however, who are so devoid of musical instinct as to be utterly incapable of benefit from musical training.

It may be added, as tending to show partly that the larynx is a simple musical instrument, partly that articulation is in a sense a function independent of that of phonation, that, in consequence of disease, the larynx has been excised by the surgeon, and its place supplied (for the purposes of speaking) by an artificial larynx, the glottis of which has been made by a metallic tongue, as in the accordion. The result has been that the patient has been enabled to speak perfectly intelligibly, articulation being (as might have been surmised) perfect, but the basis of his spoken voice being loud, metallic, and incapable of modulation.

AFFECTIONS OF SPEECH.

The subject now to be considered is one of wide extent and of great interest. It includes not merely defects in the utterance of elementary sounds, but blundering utterance, stammering or stuttering, and defects of speech dependent on affection of the supreme nervous centres. Further, it may be remarked that just as the utterance of the laryngeal sounds depends on the due performance of the function of respiration, so the utterance of articulate sounds and words demands the associated action of the purely respiratory organs, and of the organ of voice. Hence, in discussing this subject, we shall have to make frequent reference to the co-ordinate action of these several parts.

The first point to be considered is that relating to defective enunciation of literal sounds. It seems a curious fact, when one considers that the vowels differ from one another only in the presence or absence and the relative intensity of the harmonics which accompany the fundamental note (in other words, in quality or timbre), and that the differences between many of the consonants are mainly of the same kind, that the recognition of the different sounds, and the acquisition of facility in uttering them, has no apparent relation to the presence or absence of musical education or musical talent. Indeed, persons with utter incapacity for music, for the most part, discriminate and evolve articulate sounds with the utmost nicety. And it not infrequently happens that persons with marked musical talent and of musical skill display striking defects of utterance, even when the failure is altogether unconnected with defective conformation of the organs of speech. The faculty of articulate speech, indeed, is clearly independent of the faculty of music.

Defects of articulation are no doubt dependent occasionally on structural defects of the organ of articulation, but still more often on paralytic affections of the same parts. They more commonly, however, depend on defective education and the acquisition of bad habits. Sometimes they seem to be hereditary.

Loss of front teeth is a common cause of lisping. Congenital or acquired perforations of the hard palate, or destruction of the soft palate, causes the conversion of b into m, d into n, and hard g into ng, and give more or less of a nasal quality to all the sounds. A too-high palate, tongue-tie, &c., each tends to cause its own special articulatory defect. It is a curious fact, however, that removal of the tongue by operation has been shown over and over again to be attended with less impairment of articulatory power than could *à priori* have been expected. The fact, however, is that not all the articulate sounds need the use of the tongue; that the stump of the tongue which is left behind accommodates itself in some degree to the requirements of speech; and, further, that speech is generally intelligible, even when many of the letters are imperfectly uttered, provided these are associated in utterance with others that are well pronounced.

Defects of speech due to paralytic conditions of the organs concerned in speech present many varieties. We have already referred to the fact that one-sided paralysis does not materially interfere with the due enunciation of articulate sounds. In facial paralysis, where one cheek and one side of the mouth only are involved; in hemiplegic paralysis, where with paralysis of the same parts there is paralysis of the same side of the tongue; and in paralysis of one side of the tongue alone, due to affection of one of the motor nerves of the tongue—we rarely observe anything more than a little thickness or apparent slovenliness of utterance, and very often there is no noticeable defect whatever.

It is very different when the paralysis is bilateral, or involves similar parts on both sides. Occasionally, as a consequence of cold or of injury (such as a fall on the head), both facial nerves become more or less completely paralysed. In the latter case, the results are remarkable. The sufferer (though still able to roll his eyeballs, and to open and shut his jaws, by the muscles which work these parts) has lost all power over his muscles of expression. His eyes remain wide open, he can neither open nor close his lips (which always remain partly open), he can express no emotion, the natural creases are smoothed away, his face is utterly blank and expressionless, and looks like a mask. In these cases the disappearance of the true labial sounds from the patient's vocabulary is quite remarkable. B, p, m, v, f, w, are no longer pronounced, and he either drops them out of his speech, or (as is more probable) he replaces them, for the most part, by the corresponding labials d, t, n, and th.

If the soft palate be the seat of symmetrical paralysis, as we often observe after attacks of diphtheria, the failure to close it in speech imparts that nasal quality to the voice which has already been referred to as one of the incidents of absence, or loss of power, of the palate. The explosive consonants especially are replaced by their corresponding nasal continuants.

We proceed to remark on those forms of faulty articulation which depend on defective education or the persistence of bad habits. All who have had the opportunity of observing the progress of children in learning to speak know that the earliest imitative efforts result in the production of combinations of sounds which have a greater or less resemblance collectively to the words which they are intended to reproduce, but which have often so little resemblance actually that only the parent or the nurse is capable of interpreting them. If we analyse them we find that they are composed largely of the literal sounds which babies, as yet inarticulate, are in the habit of uttering in their playful or noisy moods; among which may specially be named b, p, m, and hard g. Gradually, however, and partly, no doubt, by accidental arrangements of the oral canal and aperture, other sounds are added to the *repertoire*, and these, being made to replace in words the letters which had hitherto done service for them, tend to the progressive perfection of the art of speech. The times at which children begin to speak, and those at which the capability of speaking accurately are attained, vary very largely in different cases: in part, no doubt, in accordance with the amount of imitative faculty present, in part no doubt with the child's intelligence, and in part possibly determined by the ear for music which it possesses. It is important, however, to note that while idiotic children as a rule are late in attempting to speak, highly intelligent children are sometimes late also; and that while many children with no idea of music learn quickly, musical children are not infrequently slow to speak correctly.

On the whole, the art of speaking is acquired by children with very little apparent effort; though, no doubt, correctness of enunciation is the result of that constant practice with the organs of speech which is natural to childhood. It is wonderful, indeed, to observe not only how accurately children learn to utter letters and combinations of letters to which they are accustomed, but how accurately also they imitate the tones and peculiarities of pronunciation and accent of those with whom they associate and who teach them. It is wonderful, also, to observe how great is the difficulty of disembarrassing oneself of the lessons thus learnt in infancy; and how hard, oftentimes how impossible, it is in later life to acquire facility in the utterance of articulate sounds which had not been learnt in infancy, or even to learn how to utter them. The organs of articulation lose, as life advances, the plastic quality which belonged to them in infancy. It is hardly surprising, however, that children occasionally fail to acquire the method of articulating certain sounds; and it is less surprising that having thus failed they fail to repair that error in future life.

Among the sounds which children are specially apt to fail to acquire in infancy may be enumerated that of *s* (which they mispronounce as sh or th), *th* (which they are apt to pronounce as z or s) *l*, and, more commonly than any, *r* (which is sounded as w with the lips, or also in the throat). Now there is no structural or mechanical reason whatever why each one of these sounds should not be accurately effected; and, therefore, so far as one can see, no reason why the fault of pronunciation in respect of them should not be rectified. As we have already explained, the production of the literal sounds is a simple mechanical question. If the lips, and tongue, and soft palate, be placed in certain definite positions, and breath emitted from the larynx, definite letter-sounds will necessarily result, a specific sound being the consequence of each such specific arrangement. A person has, therefore, only to arrange his organs in a certain definite manner to produce any literal sound which he may require to utter. If he arranges them in the position to sound s, s and no other letter is produced; and similarly of all the others.

There is little or no mystery with regard to these arrangements. An unskilled person might no doubt fail to work them out for himself. But there are many persons who have studied them, who know exactly what they are, and who are capable of explaining them clearly to those who require such explanation. Then why is it that persons continue such mispronunciations to the end of their lives? Mainly it is that they never take the pains to be taught or to learn; partly, it is that, even when they have learnt how they should be developed, their no-longer youthful and no-longer plastic organs fail to acquire that readiness of action in regard to them which is necessary for rapid and easy speech. We have ourselves on more than one occasion instructed such imperfect speakers how to pronounce their faulty letters, and have heard even those who habitually say w for r pronounce the r correctly. We do not know, however, that we have ever had the good fortune to cure a patient of his bad habit.

Many mispronunciations which are acquired and perpetuated are provincialisms or vulgarisms, and depend less (or it may be not at all) on actual inability to pronounce the correct sounds than on an acquired failure to appreciate and discriminate sounds the correct use of which has not been learnt by example.

The most striking case of this defect is the abuse of the letter h. All persons who have been educated to its appropriate use in infancy, and whose education has not been subsequently neglected, sound it with perfect ease and fluency in all places in which its use is required, and, on the other hand, omit it unerringly wherever its employment is inappropriate. Those, however, whose education in this respect has been imperfect, fail not so much to pronounce the letter at all, as to use it with uniformity and discrimination. The ear seems unattuned to it. They do not seem to recognise when they sound it and when they do not. As a general rule they omit it from all words in ordinary quiet conversation, but add it incontinently whenever they are excited or wish to be emphatic. Now, here again, there is no mechanical difficulty as to the utterance of the letter. In pronouncing it before any vowel, all that one has to do is to place the organs of articulation in the position which that vowel requires for its utterance, and to precede the utterance of the vowel by the emission of breath, which must be continued into that on which the vowel is sounded. Nor is it difficult to teach how to aspirate. There is, however, very great difficulty indeed in overcoming the early defect; and the greater number of persons who make the attempt fail to a greater or less extent in acquiring that facility which early training would have given them. They are apt still occasionally to drop the h when it is needed, to sound it in error when they are emphatic, and habitually (even when they sound it correctly) to pronounce it with a manifest effort and undue harshness.

Other letters which are thus apt to be misused, or interchanged, are v and w. It will be recollected how Sam Weller, when asked his name in court, pronounced it Veller, and how his father called out, "Spell it with a we, Sammy." A further example of the same kind is the omission of the sound of y from such words as *duke* and *tune*, and their pronunciation as *dooke* and *toone*.

It may, perhaps, be here pointed out that not infrequently the peculiar "twangs" which characterise the typical Cockney, and certain provincials, depend simply on the combination in diphthongal forms of vowels different from those which are used for the same purpose by persons of superior education. One of the commonest of these mispronunciations in London is the use of the long i for long a. Thus, one gutter-child will say to another, "come and pli with me," instead of "come and play with me;" or, "take care of the biby," instead of, "take care of the baby." Here the sound of the long i (whch is a diphthong, composed of a in calf and i in hit) is put in the place of long a, a letter which in other words he pronounces without difficulty.

Other defects of articulation due to bad habits or bad training are, the tendency presented by many persons to speak with the lips, or especially the teeth, insufficiently separated; and, what is even more common, of slurring letters in combination, and so uttering them indistinctly, and may be of dropping some of them altogether.

Another common defect is that of interpolating letter-sounds between others, and mostly between vowels, at the end and the beginning of words. An example of every-day occurrence is the interpolation of the letter r in such combinations as idea-r-of, and Sarah-r-Ann.

The way to remedy each of the above defects is sufficiently simple. It is, first, to call the attention of those who are in fault to the character of their faults; and then after they have been recognised fully, to show how, by careful and deliberate utterance, they may be rectified. The correction of none of them presents any inherent difficulty.

Stammering.—We now come to the consideration of a form of defective utterance which depends neither on structural defects of the mouth nor on imperfect education or bad habits, nor on paralysis of the organs concerned in speech. Nor, again, is it the result of mental defect. It seems to be due to the occurrence of a spasm or hitch in the course of utterance, which interrupts utterance for a time more or less completely. We speak of stammering or stuttering.

It may seem needless to give any description of stammering, seeing how common it is, and how well the meaning of the word is understood. It often happens, however, that what is supposed to be understood is really not understood. And as we are writing for the public, we shall assume this to be the case now.

Stammering, then, is a peculiar affection of speech in which, in the course of utterance, a sudden spasm occurs, which either checks the flow of sound altogether for a short space, or in which the arrest of speech is attended with a series of rapidly repeated sounds, which are usually those literal sounds at which the check took place.

The spasm may occur in connection with any literal sound; but the consonants suffer in this respect more than vowels; and the explosive consonants b, p, d, t, hard g and k, more frequently than any of the others. Further, it is more apt to arise at the commencement of words or syllables than in syllables where vowels and consonants are blending with one another.

In considering this subject we must not forget that the art of speaking is extremely complicated: that for the utterance of every articulate sound three distinct mechanisms have to act in unison and in due relation to each other. The mechanisms here referred to are, the respiratory apparatus, or parts specially concerned in respiration, the larynx, or the organ of music; and the mouth and structures connected with it, which collectively constitute the organs of articulation. To articulate, it is not sufficient to put our mouth, and tongue, and fauces into particular postures, we must also, at the same time at which such postures are assumed, transmit vocalised or breezy air from the laryngeal orifice through the mouth, otherwise the articulate utterances remain latent, and nothing is heard. Again, to produce laryngeal sound, air, with regulated force and in regulated quantity, must be discharged from the lungs by the action of the complicated muscles of expiration; for, without that, either laryngeal sound would be wholly absent, or it would be evolved irregularly, and in a manner unsuitable for the due development of laryngeal sounds and those of articulation. In the utterance of speech, therefore, it is obvious: that the expiratory organs must be made to regulate the transmission of air through the larynx and mouth in exact accordance with the requirements of phonation and articulation; that the larynx must vary its arrangements at the same time (first in respect of tension, for the production of higher or lower notes, and, second, in respect of modifying the laryngeal aperture from complete closure, as occurs in the production of vocalised vowel sounds and sonant consonants, to partial closure, as occurs in uttering the same letters in a whisper; and thence to complete patency, as happens during the pronunciation of the voiceless or surd consonants, such as f, s, t, p, k, and h); and, lastly, the organs of articulation must assume many varieties of position, in order to produce the many various articulate sounds of which they are capable.

It will be gathered from the above statement that, for the pronunciation of each separate letter, a complicated co-ordination or co-operation of different mechanisms must take place. But when it is recollected that words are combinations of several letters, each one of which requires its particular group of co-ordinations, and that during speech such groups of co-ordinations are succeeding one another with great rapidity, and passing like dissolving views into one another, and are associated together in almost endless variety, it will be acknowledged that the mere mechanism of speech, simple and easy as it appears to those who have acquired due command over it, is full of complicated details, disarrangement of any one of which would naturally and readily disturb the smoothness and perfection of its action.

Of the three groups of associated movements, that of the organs of respiration is the least complex and most instinctive; while that of the organs of articulation is by far the most various and complicated, the most artificial, and that which is last and most laboriously acquired. The movements of the larynx occupy an intermediate position in these respects.

Now it is found that it is mainly in those musculo-nervous mechanisms (facility in the employment of which is acquired only by long-continued practice) that disarrangements are liable to occur which interfere more or less permanently with their perfect action. Thus the skilful pianist occasionally becomes liable to recurring spasms of the muscles of the hand or arm, which mar his performance; and writers are subject to a similar condition, which is apt, sooner or later, to render writing impossible.

Speech is a typical art of this kind; and on the principles here indicated, we should naturally suppose that the impediment to its due performance might arise in any one of the mechanisms concerned, or in all of them, but especially in the mechanism immediately concerned in articulation. And so it is.

To return to the description of stammering. When the check occurs at the lips, the evolution of the labial sounds is arrested by a sudden spasmodic closure of the mouth; when at the point of the tongue, this gets fixed in the position belonging to the utterance of lingual sounds; when at the base of the tongue, this becomes spasmodically approximated to the palate. In some instances, and especially when the vowel-sounds are implicated, the spasm takes place at the glottis. And not infrequently the stammering, whether occurring in connection with vowels or consonants, is due to a sudden inspiration. But whatever part the spasm may affect primarily, the arrest may consist either in a sudden, simple, more or less prolonged spasm, or in a series of such spasms in rapid sequence, during which the implicated literal sound undergoes more or less frequent repetition. And, further, there is generally a tendency, especially if the spasm be prolonged, for a greater or less number of other groups of muscles to be involved. So that if, for example, the spasm commences at the base of the tongue, we may find in some cases that the mouth opens widely and remains in that position, the muscles of expression work convulsively, the glottis contracts, respiration becomes arrested, and finally spasmodic movements of remote parts become also excited.

The causes of stammering are various. It usually comes on in early childhood, and often at that time without any obvious cause. It may, however, arise in later life, for the most part as the consequence of some sudden impression, either on the general system or on the nervous organisation. Thus, it may follow a serious accident, sudden fright, or acute illness. It is not an uncommon incident of general paralysis of the insane, and occasionally it comes on in the course of hysteria. In the last case, and some others, it is a merely temporary phenomenon. Generally it is more or less permanent. It is important to observe, however, that it is rarely constantly present even in the greatest stammerers. There are times when their utterance is perfectly natural and continuous; and it generally happens that their infirmity becomes aggravated during bodily illness, and under the influence of any kind of excitement. It is curious that males stammer in much larger proportion than females. It is further curious that stammering rarely occurs in stammerers when they whisper, or when they sing or intone.

Can stammering be remedied or cured? This is, of course, a very important question. The fact that certain varieties of stammering are simply accidental, and of short duration; that stammering coming on in childhood occasionally gets well spontaneously; that even the worst stammerers are at times ready of speech; and that stammerers, as a rule, do not stammer when they whisper or sing, may be regarded as proofs that stammering is, to some extent at any rate, remediable. Nevertheless, it must be admitted that persons who become stammerers in early life rarely lose their infirmity. Some, indeed, who aim at becoming public speakers, get over the difficulty by intoning their speech. It was thus that a well-known clergyman, now dead, who was a confirmed stammerer, learnt to deliver his sermons.

But the practice is, to say the least, disagreeable to those who have to listen. Moreover, it cannot be adopted in ordinary conversation. The fact of stammering being often worse when patients are out of health shows that the maintenance of good health is an important element in the treatment of these cases. And on this account tonics, and perhaps especially the so-called "nervine" tonics, are often useful. The treatment, however, on which chief reliance must be placed is educational, and its success will depend largely on the patient's own perseverance. He should learn to speak slowly and deliberately; and, however excited he may feel, should make a point of not giving way to excitement, or of attempting volubility. He should learn so to regulate his respiration in the course of speaking that he should never be in want of breath for the purposes of utterance. He should make a point of never making persevering efforts to overcome the impediment when it arises, for this only increases the difficulty. The proper method is for a second or two to avoid making any attempt, and then to begin at the word or letter at which he stumbled. We know of several stammerers who have practically cured themselves in this way, and in whom the only trace of its previous existence is the occasional momentary pause they find it necessary or convenient to make. Lastly, it may be well for stammerers to practise, when alone, those letters at which they are specially apt to stumble, and more particularly to practise them in combination with other literal sounds.

Blundering Enunciation.—Another defect in speech to which persons are prone is that of stumbling or misplacing letters or syllables. "Thumbers and fing," "tags and ratters," are examples of the kind of stumbling which is of most frequent occurrence. And the well-known alliterative discourse about "Peter Piper," and others of the same kind, have of course been invented for the purpose of exposing this tendency, and causing amusement at those who display it. But stumbling includes the occasional use of wrong words, and even an occasional hesitation or stammer, even in persons who are not habitually stammerers. Defects of this kind are much more common in some persons than in others, and are largely due to, or at any rate are much increased by, carelessness, inattention, and hurry in utterance, and by nervousness. The fact of being out of health too, being dyspeptic, having a headache, and even temporary local discomforts, such as a sore throat, a pimple on the tongue, a broken tooth which frets the tongue or cheek, and even mere febrile dryness of mouth, are all liable to increase the ever-present tendency.

The remedies for the above state of things are in the sufferers' own hands, and are sufficiently indicated in the above account.

Forgetfulness of Names.—One of the most interesting defects of speech to the physician is that to which the name of aphasia is generally applied. It presents many varieties, both in kind and in degree. In one form, which is comparatively rare, the patient loses absolutely the power of uttering any articulate sound, being apparently well (probably) in every other respect. He hears and understands all that is said to him; he sees and understands all that he reads; he can communicate his ideas by writing as well as ever he did; he can open and shut his mouth, can move his tongue freely, can masticate and swallow without impediment; he can, in fact, use his muscles of articulation for every other purpose than articulation with perfect ease and facility—yet, if you ask him to speak, if you ask him to read, he is as much at a loss to utter even a single articulate sound as a man who had never seen or heard of a telegraph apparatus would be to convey messages by means of it.

This latter simile probably furnishes the real explanation of the phenomenon. The loss of power of speech is probably always due to some local affection of the brain which interrupts the passage of those telegraphic messages which, emanating from the supreme centre for speech in the surface of the brain, should, in order to effect speech, act upon the subordinate motor centres, or agents, by means of which the complex arrangements for speech are co-ordinated. Such patients sometimes recover the faculty of speech spontaneously, and even suddenly. And occasionally, where the condition becomes persistent or chronic, they admit of being taught again how to speak. It will be recollected that we have shown speech to be a mere mechanical art; and that if only the organs of speech be arranged in certain positions, and breath be emitted, letters due to these positions must be developed. Now, considering that these patients for the most part retain their intellectual power, and have perfect control over all strictly voluntary movements of the tongue, the possibility of successful education becomes apparent.

The more common form of aphasia is that in which the patient forgets words and misapplies words. To a certain extent this is a condition to which most persons are more or less prone. There are but few persons who are not, when speaking or writing, liable to forget the word which they specially want to use, and are especially apt to forget the names of things. And, indeed, unless the name arises automatically, or without thought (as it were), the difficulty of recalling it is sometimes extreme. One of the most curious examples of this kind of forgetfulness which we can call to mind is that of a lady of our acquaintance, who, being driven in her carriage to a shop where she was unknown, and having made her purchases, forgot her own name when she was about to direct the shopman where to send them; and being then asked to give her address could not recollect that either; and had to go to the door and ask her own coachman what her name and address really were.

In this form of aphasia, however, due to disease, the symptoms are much more pronounced and much more persistent. The forgetfulness is not the mere occasional forgetfulness of a word. But such forgetfulness pervades the patient's conversation, writing, and reading.

In a typical case he forgets the names of the commonest things, and even his own name and age, and where he lives; and often, moreover, has a tendency to repeat one word as the name of everything that is held up to him. Thus, if asked to name the finger, he may either fail to reply, or call it a spoon; and if told that it is a finger, he is apt to repeat the word finger as the designation of the next object which he is asked to name. At the same time, probably, he recognises the proper names when they are mentioned before him, although he does not recollect them the next moment. In reading, the same defects show themselves—most of the words and most of the letters he is quite unable to name; but, probably, here and there he recognises a word or letter, just as one beginning to acquire a foreign language here and there recognises a word amongst the many of which he has no knowledge. In writing also his defect becomes equally apparent; if asked to write his own name he often commences fairly well with its first letter, but soon begins to repeat it more or less imperfectly, and presently lapses into the formation only of meaningless up and down strokes.

In an extreme case the patient's only response to questions is probably "yes" or "no," applied without relation to their actual meaning, or some such phrase as "can't afford it," or an oath, which slips out incontinently, and at times apparently against his will and to his annoyance. Here, probably, the patient is wholly unable to read or write. In slight cases there is, perhaps, only the persistent oblivion of certain names, or a tendency to omit or to interpolate certain letters; peculiarities which reveal themselves also in his writing.

Curious facts, noticeable in some of these cases, are (and this is the more common) that, though they cannot think of words, they will repeat them readily to dictation; and that in cases where the patient not only forgets words, but is in the habit of reading, or of writing spontaneously or to dictation, he will translate with perfect facility and accuracy a printed paragraph placed before him into its equivalent in written characters, without understanding in the least the words which he has thus transcribed. This latter defect, however, is comparatively rare.

This condition of aphasia has been shown to be due either to disease implicating a definite small region on the surface of the left side of the brain, which region is regarded as the cerebral centre for speech, or to some damage which interrupts or destroys the nervous connection between this and other parts of the brain. The determination of this region is regarded as one of the main foundations of the modern views with respect to the localisation of the cerebral functions. Similar disease on the right side of the brain very seldom indeed exercises any like influence over the function of speech, excepting in the case of left-handed persons, in whom there is reason to believe that the left-handedness is associated with a similar transposition of cerebral preponderance.

Persons who suffer from this affection are usually paralysed on one side of the body, and (since the influence of the brain over the body is crossed) almost always on the right side. Further, although some recover more or less completely from this aphasic condition, the majority remain more or less defective of speech. It is curious, however, that many of these persons appear to be in all other respects clear of mind and intelligent, and competent to perform the ordinary duties of life.

In cases of the above kind, the attempt to teach the patient is practically useless. Now and then with much labour one or two fresh words may be impressed upon him for a time, but no real improvement is effected by such means. Their recovery, when it takes place, is due to the dispersion of the lesion causing it, or to the restoration of the parts to health.

Hints as to Public Speaking and Singing.

Before we conclude our observations with respect to articulation and phonation, it may be well to make a few remarks concerning public speaking and singing, which represent these arts, or should represent them, in their highest phases of development.

Speaking.—Very few persons, unfortunately, with whom public speaking becomes a profession, or whose position in life compels them to speak frequently in public, take any trouble to learn how to speak effectively and agreeably, or to overcome those natural defects or acquired bad habits which mar their performance. One reason no doubt is, that boys are rarely taught to read intelligently or instructed in elocution, so that by the time adult age is reached their faults have become stereotyped and difficult or impossible to cure. It is obvious, however, that the greater this early neglect, the more imperative do study and practice later in life become. And it is really inexcusable that our pulpits and lecture halls should be occupied, as they too often are, by speakers who have obviously never taken the slightest pains to qualify themselves for the duties they undertake to perform. We do not profess to teach persons how to become public speakers. Yet there are certain hints in regard to this subject which naturally arise out of the discussion in which we have been engaged.

In the first place, a speaker should give the greatest pains to the accurate and complete articulation of his words. He should take care that every letter that ought to be sounded be sounded fully, and that his words be begun and ended crisply and cleanly. To this end it is especially necessary that all natural slovenliness of articulation, all tendency to slur or to drop letters, all such defects as lisping and the like (which are capable of cure) should be subdued.

In the second place, the musical element of the voice, that part of it which is produced at the larynx, requires the nicest management. Upon this the strength and volume of the voice depend. The loudness of the voice should always be regulated by the distance to which it has to be carried, or the space it has to fill; and, hence, it is usually advisable for the speaker to assume that he is addressing those who form the fringe of his audience. If it be possible it is well to test his voice beforehand in the place in which he is about to make a speech; always, however, bearing in mind that it is necessary to speak louder in a room filled with people than in an empty room. Again, although no doubt a public speaker will need, while speaking, to modulate his voice according to a variety of conditions which we do not propose to consider now, it is still necessary, in order to be well heard, and to make the best of his voice, to regulate its general pitch according to the requirements of the occasion. Thus it is generally undesirable to speak in a relatively low key; and if a large area has to be filled it is specially important, for acoustic reasons, to pitch the voice high. Further, the voice should always be sustained. The tendency, we might almost say the natural tendency, amongst uneducated speakers, is to drop the voice often at the end of polysyllabic words, but especially to drop it at the end of sentences, and thus to become almost inaudible. The voice, we repeat, should be sustained not only throughout words but throughout sentences, and to the very end.

In the third place, and this relates both to articulation and to phonation, the speaker, in order to emit his words clearly and accurately, should take care to give free play to his organs of speech, and therefore to open his lips and teeth and throat as widely as the correct enunciation of his literal sounds will allow. Especially he should not speak with closed teeth or constricted throat. To the same end, the speaker should always hold his head up, and direct his speech to his auditors.

In the fourth place, he should be careful not to be too rapid, for rapidity leads to, or perpetuates, many of the faults above referred to, largely promotes inelegancy and inappropriateness of diction, and renders even good speaking difficult to follow, and unimpressive; and he should acquire skill in so arranging his inspirations that he may never be out of breath, or appear to be making an effort.

In the fifth place, he should look out for and suppress all bad habits which take from the effect of speaking: he should avoid all sing-song, and monotonous, stilted, and flippant modes of delivery; he should learn to put the emphasis on those words which need emphasis; he should avoid the use of all those inarticulate sounds which so many speakers interpolate between their words, more particularly when they hesitate; and, further, he should weed from his discourse all such expressions as, "You know," "Don't you know?" and many others which have no relation to the subject-matter, and no meaning.

And, lastly, let us add, that, while only few men possess the special gifts which combine to make the orator, there are few who with practice cannot acquire more or less facility in speaking fluently, and pleasantly, and clearly, provided they overcome original bashfulness, take the trouble before speaking to understand the subjects on which they are going to speak, and to arrange their matter and their argument, and while speaking stick to their text.

Singing.—Some of the remarks just made apply equally to singing. We shall not presume to enter at any length into this subject. But we may point out that accuracy and clearness of articulation, the free opening of the mouth and throat, so far as the due enunciation of articulate sounds permits, the addressing of oneself to one's audience, and the adaptation of one's voice to the space it has to fill, are as essential in singing as in speaking.

A common fault amongst singers is indistinctness of articulation, whereby the hearers are not permitted to understand the words that are supposed to be uttered, and so lose half the pleasure of listening. Another fault, connected with articulation, which uninstructed singers fall into, is in the management of the vowel-sounds, and especially of those which are diphthongal, that is, in which two vowel-sounds are combined in immediate sequence. On certain of the short vowels, such as *u* in *hut*, it is impossible to sustain prolonged notes; and, if it be attempted, the vowel alters in character. And in regard to diphthongal sounds, such as long *i* (which is made up of *a* as in *art* and *i* as in *hit*, which latter when prolonged becomes *e* as in *meet*), the common uninstructed tendency is for the first part, *a*, to be uttered shortly, and thus for the latter when prolonged to develop into the utterly different sound of long *e*.

In reference to both of these subjects, we may observe that, whilst careful training and constant practice are needed for the full development of the performer's vocal powers, and for their due preservation, injudicious training and injudicious practice are apt to be injurious or ruinous. One of the most perilous practices both for the speaker and for the singer is that of straining the voice, and especially of persistently straining the voice when the throat, and consequently the vocal cords, are congested, inflamed, or "relaxed." Under the influence of such affections the cords are apt to get impaired in their elasticity, and to become more or less weak and yielding; and the tension and violence to which they are exposed during persistent vocalisation is thus apt to damage them seriously, and perhaps permanently. Further, the constant irritation of the inflamed soft parts about the vocal cords is apt to be followed by permanent thickening and other changes. It is owing to such a combination of circumstances that professional speakers become the subjects of that impairment of voice, with irritability of the throat, which, when it affects clergymen, is known as the "clergyman's throat;" and that professional singers are not infrequently compelled to give up their means of livelihood. We know at the present time an excellent public speaker who some years ago ruined a naturally fine voice in this way, and who has ever since spoken in hoarse and uncertain tones. We may well admit the plea of a sore throat, which the public is apt to think is too often made by public singers, as a valid excuse for their declining to fulfil engagements. Their voices are their stock in trade, and we have no right to require them to damage them for our pleasure.

The foregoing remarks are to a large extent applicable to the excessive use of the voice in children before the organs of voice are fully developed, and especially to their excessive use about the time of puberty, when the voice is undergoing momentous developmental changes.

CATARRH.

This name is given to the affection, ordinarily termed a cold, which is usually induced by exposure to cold or wet, or both. It is sometimes contagious. It is an inflammatory condition, affecting mainly the tracts of mucous membrane which have been under consideration, and having a tendency to spread both in surface and in depth. It begins sometimes in the nose, with irritation, dryness, stuffiness, and tendency to sneeze, followed first by the discharge of thin, irritating mucus, and later by a thick secretion; sometimes in the soft palate, with soreness, itching, and dryness; sometimes in the larynx, with sore throat, hoarseness of voice, and tendency to cough; and sometimes in the chest, with the ordinary symptoms of bronchitis. Or it may involve all these parts at once. Further, such inflammation often spreads along the nasal ducts to the surface of the eyes, inducing ophthalmia; along the Eustachian tubes into the ear, causing ear-ache and deafness; into the frontal sinuses, inducing frontal headache; and sometimes to the deeper tissues, in which case periosteal inflammation, neuralgia, and toothache result.

Catarrhal inflammation may be slight or severe; and, in the latter case (where the larynx becomes involved), we have the formidable disease to which the term laryngitis is applied, a disease in which the affection of the throat rapidly induces difficulty of breathing, and not infrequently death from asphyxia.

The liability of persons to catch cold varies remarkably. The preventive rules applicable to one person, therefore, may often be safely disregarded by others. There are certain conditions, however, which are specially liable to be followed by catarrh. These are: long exposure to cold, especially if at the same time one's clothes are wet; and draughts playing on the surface, particularly about the head and neck. Cold and wet, however, rarely cause catarrh if the person exposed to them is keeping the surface warm by active exercise. But if he be fatigued, or the exercise he is taking be insufficient to maintain surface-temperature, or if, after exposure to great heat, he stands or sits in the cold air, and becomes chilly, catarrh is specially likely to supervene. These are conditions, therefore, which those liable to colds should be careful to avoid. It is often recommended for such persons that they should habitually take a cold bath in the morning. As a general rule, no doubt, this recommendation is a judicious one; but there are some who always feel chilly after a cold bath, and in whom such a bath frequently causes more or less headache, roughness of throat, and running at the nose. It need scarcely be said that in these cases a cold bath is contra-indicated. A tepid bath, however, and a good rub down with a rough towel afterwards, is always beneficial. Persons liable to colds should also always be very careful to be warmly clad, especially in changeable weather.

ACCIDENTS TO BE AVOIDED.

Accidents which occasionally happen to the œsophagus and windpipe are the lodgment of solid bodies in them. Sometimes a fish-bone, sometimes a pin, sometimes a set of false teeth, finds its way into the former tube. If they pass on to the stomach, little or nothing can be done, except to wait for the result, which is almost always favourable. If they be arrested in the œsophagus, they often become dislodged, sooner or later, during the swallowing of solid food; or they may be removed by surgical interference. Sometimes large angular bodies, such as false teeth attached to a plate, become impacted, and remain in the gullet in spite of all measures that may be adopted to remove them. In one case with which we are acquainted, such a body remained fixed for many months, interfering seriously with the taking of nourishment, and leading to extreme emaciation and debility. It caused ulceration, however, where it lay, and at length fortunately was vomited up.

The lodgment of foreign bodies in the larynx or other air-passages is a matter of much greater seriousness. Every now and then we hear of persons who, while eating, are attacked with sudden complete obstruction of the windpipe, and who, after frantic efforts to breathe, die of asphyxia in the course of a minute or two. This occurrence is often due to the accidental swallowing of a large mass of unchewed meat, and its sudden impaction at the top of the larynx, a condition which might have been relieved (by any one who suspected what was the matter) by passing the fingers into the throat and dislodging the mass. But often smaller bodies are suddenly sucked, with more or less sense of choking in the transit, into the larynx, and thence find their way into one of the bronchi. Pins, small coins, and fruit-stones, are some of the commonest of these intruders. It is difficult to recommend what to do when such accidents occur, beyond consulting a medical man, for it is always a serious question whether anything should be done, and if any course be determined upon, it needs to be conducted with skill and care. It may be well, however, to point out that, in order to prevent such accidents as far as possible, persons should never hold pins and other such things between the teeth, should never catch small bodies in the mouth, and should avoid laughing or suddenly inspiring when eating or drinking.

Other accidents, often fraught with extreme danger, are the swallowing of corrosive fluids, and (especially in young children) the drinking of boiling water from the spout of a kettle. These matters naturally find their way to the stomach, wherein they do more or less damage ; but they are also extremely apt to cause severe inflammation and swelling of the throat and larynx, over which they pass, and thus to induce intense laryngeal symptoms, which often prove fatal.

THE TEETH.

By Charles S. Tomes, F.R.S.

Introductory—The Causes of Dental Caries—Defective Teeth—Overcrowding, &c.—Filling or Stopping —Gum-boils—Toothache and Neuralgia—Accidents to the Teeth—Premature Loosening—Care of Teeth in Childhood.

The teeth of uncivilised races of mankind are of such quality that, like the teeth of animals, they do not call for, and of course do not usually receive, any special care. And notwithstanding this neglect of attention, they rarely succumb to any disorder, nor do they fail their possessor prior to the attainment of old age, unless indeed it is that, as sometimes happens, they are actually worn away to a destructive extent by the coarseness of the food. But amongst the more highly civilised communities a widely different state of things exists : it is no uncommon thing for the teeth of an individual—shown, by the tests of vigour of frame, of endurance, capacity for work, and longevity, to be otherwise healthy—to have been largely destroyed by disease, even before the attainment of middle life, whilst the existence of the entire number of sound teeth in the mouth of a person who has attained old age is rare enough to be talked of as remarkable. Hence, the civilised man cannot afford to treat his teeth with that measure of neglect which is accorded to them by the savage, but, supposing him to be healthy, of all his organs they alone are almost sure to require some form of attention comparatively early in life.

The exposed portions, or working surfaces of the teeth, are coated with enamel —a substance exceedingly hard, but at the same time somewhat brittle, which terminates just beneath the free edge of the gums. Beneath this, forming the great mass of the tooth, comes the dentine—a substance which, while less hard, is exceedingly elastic and free from brittleness : its elasticity is well exemplified in a billiard ball, which is made of ivory—the dentine of an elephant tusk. That part of the dentine which forms the roots of the teeth is coated with cementum—a substance very closely akin to bone, and, like it, permeated with soft, living tissue. There is a central space which corresponds roughly in form with the exterior of the tooth, whilst entrance to it is gained at the point of each root. In this central hollow, when the tooth was alive, lay the "nerve," or, as it is termed by anatomists, the "pulp"—a term to be preferred, inasmuch as, though it is exceedingly rich in nerves, it is made up of blood-vessels and a considerable quantity of other tissue as well.

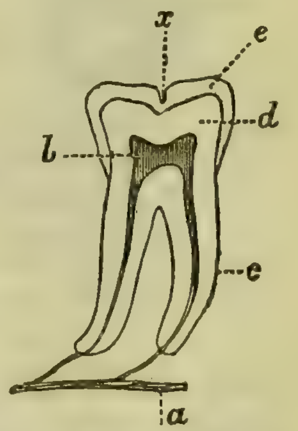

Fig. 1.—A Longitudinal Section through a lower Molar Tooth.

a, Nerve sending up filament; *b*, Pulp chamber; *c*, Cementum; *d*, Dentine: *e*, Enamel; *x*, Fissure in the middle of the crown of the tooth.

The sensitiveness of the dentine asserts itself unpleasantly where the tooth has been denuded of enamel by excessive wear, by filing, or by fracture, and adds much to the pain involved in dental operations. The sensitiveness of dentine is due to minute filaments, which penetrate it everywhere, and which are in communication with the "nerve," so that tenderness in a decayed tooth may be very acute without the "nerve" being exposed.

Diseases of the Teeth.

The disease which destroys such vast numbers of the teeth of civilised peoples is called "dental caries;" in it the tooth substance becomes softened, more or less discoloured, and finally breaks up; if unchecked, this process goes on until the central "nerve" is reached, and then severe toothache generally, but not always, ensues. No acid capable of softening tooth tissues exists in a healthy mouth, but the vegetable acids, generated by the fermentation of animal and vegetable substances and of the mucus of the mouth, will not only do so, but by their employment a tolerable imitation of dental caries may be produced out of the mouth. Granting this, it will be seen how favourable to the occurrence of decay any nooks or crannies in which particles of food may lie undisturbed for a time must be, and how the want of cleanliness will work in the same direction. And recent researches have shown that carious dentine is penetrated to a considerable depth by *bacteria,* but the exact share taken by them in its disintegration is not known.

It is customary to speak of "brown decay" and of "white decay," as if the latter were a different affection; this, however, is not the case, the pale colour being merely an index of the rapidity with which the disease has progressed, the softened tissue not having had time to get deeply stained.

The centres of the masticating surfaces of molar and bicuspid teeth are the commonest of all situations for decay, and this may occur in teeth which are otherwise of very satisfactory structure. In an upper molar, here figured, deep fissures (x) exist at the junction of the several cusps (Fig. 2).

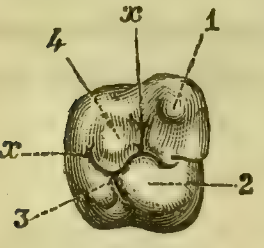

Fig. 2. — Masticating Surface of a Molar Tooth, with its four cusps numbered 1, 2, 3, and 4, and the deep fissures which separate them (x).

The dentine is rarely imperfect, but when such a tooth is seen in section, the enamel is found to be almost wholly deficient at the bottom of the fissure (see Fig. 1).

After what has been said about the power of fermenting mucus or food to develop acids capable of attacking the dentine and the enamel, it will be seen how favourable a spot for the commencement of mischief is thus afforded; but, on the other hand, decay having once occurred in this situation, and having been thoroughly excised and the resultant cavity filled, a good result may be expected, for the former conditions under which the tooth decayed no longer exist. But far more widely-spread deficiencies may occur in the enamel.

The teeth generally described as "honey-combed," or "craggy" (Fig. 3), may be taken as a record of a period of ill-health; it is known that they are of frequent occurrence in the mouths of those who have taken much mercury in infancy, and some would regard them almost as proof of the administration of that drug, in teething powders or otherwise. Rings, like the marks across the nails of those who have suffered from acute illness, also mark periods of interruption of the normal steady course of tooth development.

Such teeth, from their ruggedness of surface and partial deficiencies of enamel, are very liable to decay, and are difficult to treat satisfactorily, inasmuch as the carious cavities are not bounded by healthy, well-formed tissues.

Another frequent cause of decay is overcrowding of the teeth. In a perfectly normal, well-formed jaw the teeth are individually so shaped and are so arranged that they touch one another by curved surfaces only, so that the areas of contact are very small (see Fig. 4). As teeth are not rigidly fixed, but are capable of a small degree of motion, they rub against their neighbours, and in time wear the curved surfaces of contact into small flat facets, but still the areas of contact remain small, and are well removed from the gum.

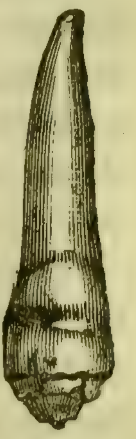

Fig. 3. — A "Honeycombed" Upper Canine. The tip of the tooth has very craggy irregular enamel, whilst the rest of the crown, which was formed later, is coated with well-formed enamel.

But in a crowded mouth, this is all altered; the teeth standing irregularly come into contact with their neighbours by other than the proper surfaces, and oftentimes they touch over a far larger area, extending right down to the gums. And when the oft-repeated slight motions of the tooth begin to take effect, enamel is crushed or worn away over irregular areas, which, damaged thus, as well as by being lurking places for fermentation to go on in, become the starting points of decay.

The more delicate the teeth, the less can they afford to be exposed to the disadvantages of an overcrowding which teeth of stronger build might be able to long withstand without detriment.

Dental caries is a disease which, without any exception, commences from the outside of the tooth; therefore the enamel is first attacked. The dentine when once reached is attacked with far greater rapidity than the enamel, so that there comes to be a comparatively large mass of soft dentine to which access is given through only a small hole in the enamel. At this stage the patient is usually not aware of the existence of any mischief, and it is in order to ensure the detection of cavities at this early stage that a periodical inspection of the teeth by a competent dentist is so necessary for their preservation.

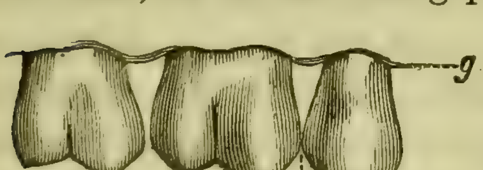

Fig. 4.—The second Bicuspid and first and second Molar Teeth, showing that the normal surfaces of contact (*x*) are very small.
g. Line of the edge of the gum.

Then, as the softening proceeds, the pulp, or "nerve," begins to be sensitive to changes of temperature, and finally commences to ache. It cannot be too strongly impressed upon those who wish to preserve their teeth that, when a tooth has once really seriously ached, the most favourable time for filling it has gone by, never to return. But, supposing that the disease has been detected in good time, the dentist's first care is to cut away all portions of the tooth so weak that they would be likely to break away subsequently, and then to remove all the softened and damaged tooth substance; having done this, he has to make choice of the material with which to fill it; and as no little misconception prevails on this subject in the minds of the public, it may be well to say a few words about it here. If a tooth is very sensitive to changes of temperature, and has been aching a little, no metallic filling can safely be used, as the mass of metal, being a good conductor, would, as respects shocks being conveyed to the pulp by heat or cold, leave the tooth as badly off as it was when empty. Of non-conducting fillings there are gutta-percha, and various white cements which are introduced in a plastic state and subsequently become very hard. Gutta-percha in protected situations forms a valuable and fairly durable filling; it is, however, wanting in hardness. The plastic cements, on the other hand, leave nothing to be desired on the score of hardness, but are sooner or later attacked chemically by the fluids of the mouth, and waste away. The foregoing temporary fillings are tolerated by teeth which would tolerate nothing else, and such teeth having been closed up with them for a year or more usually become so much less sensitive that a metallic filling may safely be inserted afterwards.

Supposing, however, the tooth to be fitted for the reception of a metallic filling, the choice lies between gold, tin, and various analgams. From causes not fully understood the same chemically pure gold may be in two different physical conditions: in the one it is readily adaptable to the walls of the cavity, but the several portions in which it is introduced have no cohesion between themselves, and the filling is retained and made hard by wedging in piece after piece, and when completed the several portions are, as it were, keyed in. This is technically called a "soft gold" filling; but there are many cavities in which from their shape, or from the fragility of their walls, the requisite wedging action cannot be secured, and then the other, or "cohesive" form of gold, must be used. "Soft" foil may be at once converted into "cohesive" foil by making it red hot; each fragment then readily coheres to the others, and may be welded up into a solid and inseparable mass. The advantages which it possesses are counterbalanced by certain grave disadvantages. It is not so plastic nor so adaptable to the walls of the cavity, so that a watertight plug can only be made by using it in exceedingly small pieces at a time, and with a degree of care that is unattainable in situations difficult of access. Hence, there is a greater likelihood of the filling failing to be watertight; and at least the operation is immensely prolonged by the necessity of adding very small amounts of gold at a time. This is termed a "cohesive gold" filling, and the expenditure of much time, and thê use of some form of mallet for condensation, are almost indispensable. Each has its merits and its demerits, and, it may be said, in a general way, that the English School of Dentists incline towards the too exclusive use of soft gold, and the American towards the too exclusive use of cohesive gold, the balance of opinion being towards the use of soft gold wherever it will answer the purpose, and of cohesive where it will not.

In proper cases a gold filling is without doubt the best, but there may be teeth in which it is absolutely not the best filling for durability, and there are others in which the long time, expense, and endurance called for on the part of the patient are such as to render it doubtful whether it is worth while to incur them. In cavities of great extent, with very frail walls, amalgam fillings are largely had recourse to. Amalgams discolour more or less; yet they differ greatly in this respect, and much of the bad name which amalgam fillings have got is the outcome not of inherent defects in the material, but of the careless and hurried manner in which it has been inserted, the plasticity of an amalgam containing an excess of mercury lending itself to careless manipulation.

Perhaps no place will occur more appropriate than this for saying what may be, and what may not be, expected of a filling. A tooth taken in the early stages of decay, and skilfully filled, may generally be said to be restored to the point from which it started, but it is not any stronger nor any better than it was before, and as decay seized upon it when it was at first intact, so it may again after it has been filled, no matter how perfectly. On the other hand, the first decay has very frequently attacked some point especially vulnerable, whether from position or from some original defect in structure, such as the pits in the enamel represented in Fig. 1.

As a matter of fact, a very high percentage of success is attainable, and few teeth of good quality need be lost if they are not neglected.

When decay has penetrated somewhat more deeply, the nerve may become absolutely exposed, or it may inflame without actual visible exposure. Then it generally aches severely but not continuously, and often, after an attack of the most violent throbbing toothache, dies somewhat abruptly. Then there is a rather sudden and quite complete relief from all pain; but it is a false security, for it is usually only a pause before the on-coming of a new series of troubles. The dead pulp decomposes, finds its way out at the end of the root, and a violent inflammation is set up. This runs on to the formation of matter, which has got to escape; it is confined between the root of the tooth and the bone of the socket, and until it can get out through the root, or by boring a way for itself through the bone and the gum, there is a state of tension which causes great suffering. This is a "gum-boil" (Fig. 5)—such abscesses in the vast majority of cases being caused by teeth with dead nerves. It is quite necessary to discriminate between these conditions, because the treatment appropriate to the one is not that likely to benefit the other.

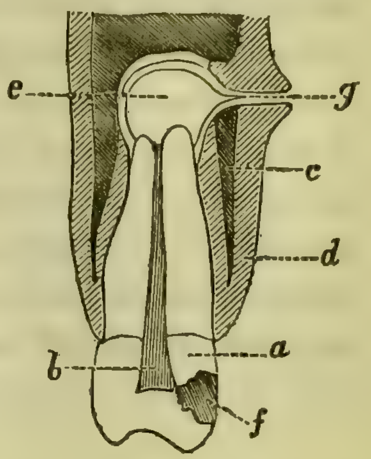

Fig. 5.—Diagram of a Tooth in its socket, with a Gum-boil over the apex of its root.

a, Crown of tooth; *b*, Empty pulp chamber; c, Bone of the socket; *d*, Gum; *e*, Abscess sac of the gum-boil; *f*, Cavity of decay, opening into the pulp chamber; *g*, Opening of the abscess upon the gum.

When a tooth aches intermittently, the pain coming and going suddenly; when it is exceedingly susceptible to shocks from hot and cold things, or is soothed by cold and aggravated by hot applications; when the pain is widely diffused over the face or the neighbouring teeth, so that it is not easy to say which tooth is aching; and when the whole tooth is free from tenderness when pressed down into its socket—it may be presumed that the nerve is alive, and that its irritated or inflamed condition is the source of the pain. There are many substances which act as sedatives to an aching pulp, the foremost place amongst which must be given to strong carbolic acid. It is, however, so caustic that as a domestic remedy it is not to be recommended; but creosote is nearly as efficacious, and is not very caustic. It should be applied on a tiny pledget of cotton wool, carried well into the cavity, and confined there by a larger pledget dipped into a solution of some resinous gum, such as mastich, sandarach, or benzoin; oil of cloves, thyme, or peppermint, are also capital applications. Another convenient application is the following paste: oil of cloves half a dram, creosote half a dram, mastich a dram, and yellow wax a dram. But if the inflammatory action has run very high, the pulp must die naturally or be destroyed before the pain will cease.

So much for toothache from a living pulp; on the other hand, if a tooth feel to be raised up in its socket so that it seems too long, if it is very tender on being pressed into its socket, and if pressure upon the gum opposite to the end of its root detects any tenderness and swelling, and, above all, if any swelling of the gum or face is coming on, it may be concluded that the nerve is dead, and that an abscess is imminent, or has already formed. The first and principal thing to be done is to give free exit to any matter. The tooth must be opened and *left open;* the filling, if there be one in it, must be got out or drilled through, and antiseptics used in the cavity of the tooth. The relief of pain is usually obtained simply by opening a road for the exit of pent-up pus or exudation. And, therefore, to tightly shut up the tooth, no matter what you put in it, is the greatest possible mistake, for the tooth will only tolerate being firmly closed after all discharge has ceased. In the early stages of the inflammation applications of tincture of iodine to the gums over the roots of the tooth are often useful, as also of tincture of aconite, but this latter is too potent a poison to be trusted to lay hands, and a fatal result has actually occurred from its use by an ignorant patient.

Furthermore, the nerves of teeth may become converted into bony matter; this is prone to happen when they are irritated by the near approach of decay, and seems to be an effort of nature to bar out the decay; but it is not always fortunate in its results, as the teeth are apt to ache, or to set up neuralgia, and so necessitate the destruction of the nerve or the extraction of the tooth. In some persons it occurs in perfectly sound teeth, and its existence can only be inferred from symptoms.

Toothache and Neuralgia.

In some constitutional conditions pain is felt in the teeth and gums although no disease can be detected in either, and this is specially apt to occur in women who are *enceinte.* On the other hand pain widely diffused all over the side of the face, such as most people would describe as neuralgia, may be entirely due to teeth in which no local pain has ever been felt, so that the sufferer's suspicions have never been roused by anything recognisable as toothache. Pains of this nature are aggravated by fatigue, and benefited by food, wine, or quinine, just like all other neuralgias, so that a certain diagnosis is only to be made by very careful examination of each of the teeth, and may even then rest in some uncertainty. And though there are, of course, some with which the teeth have nothing to do, yet a large number of cases of so-called neuralgia are dependent solely on diseases of teeth which admit of easy cure when once detected.

The commonest condition found is an exposure of a nerve in such a place that it is sheltered and seldom gets touched; but it may also arise from irritation around the roots of a dead tooth, from exostosis of a root, or from calcification of a nerve.

Accidents to Teeth.

When a considerable fragment of dentine has been broken away, the pulp becomes nearly or quite exposed, and the various troubles resultant upon this will surely ensue, so that to obviate them measures should be promptly taken for the extirpation of the pulp.

And it will often happen that the pulp of a tooth will be killed by a blow which does not fracture the tooth at all: that this has occurred will be indicated by tenderness supervening in the socket of the tooth after the lapse of a week or more, and if this warning be neglected, a deep discoloration of the tooth by its infiltration with the products of the decomposed pulp, and ultimately an abscess, will ensue; hence, no time should be lost in having it attended to.

A tooth knocked out, and at once replaced in its socket, will, in a large number of cases, reunite; it should be carefully washed in warm water, the vacant socket cleared of blood clots, and the tooth pressed firmly home into its place: it should be disturbed as little as possible, and with that view the diet should be limited to soft things; if going to reunite it will be pretty secure in two or three days. The longer the tooth has been out, the less the prospect of success; but the present writer once succeeded with a front tooth which had been out for twelve hours, and had become thoroughly begrimed. And the extraction, filling, and subsequent replacement of a tooth is occasionally practised as a last resource in cases of otherwise incurable gum-boil, but its value as an every-day line of treatment has yet to be established.

About a century ago, as is curiously illustrated in a caricature by Rowlandson, those who had their own front teeth disfigured would bribe a poor child from the streets to have a sound tooth extracted, which was to be instantly inserted into the socket whence their own unsound one had just been removed. This practice soon fell into disuse for various good reasons, one being that the transplanted tooth often became loose and fell out.

The Loosening of Teeth.

It would seem to be an occurrence so usual that it may almost be said to be normal, that the teeth should become loose by the absorption of their bony sockets, and fall out in advanced old age. Not very much can be done to obviate the decay of nature, but thorough use of the teeth in mastication, friction upon the gums, and the keeping them thoroughly clean from tartar, will do something to prolong their usefulness.

When, however, the gums begin to part from the teeth, and the teeth themselves to loosen, in a person who has not yet attained to old age, the condition is more amenable to treatment.

In such a case slight deposits of tartar are almost always to be detected upon the teeth far below the level of the gums (Fig. 6). Where the gums have become detached from the teeth, the tartar must be carefully removed; but it would seem that the site of the disease is really at the edges of the bony sockets. If these edges be scraped so as to get a fresh and healthy surface, the most beneficial results often follow, the loose teeth becoming fast, and the disease apparently quite averted. But such good results are not always to be obtained, and relapses often occur.

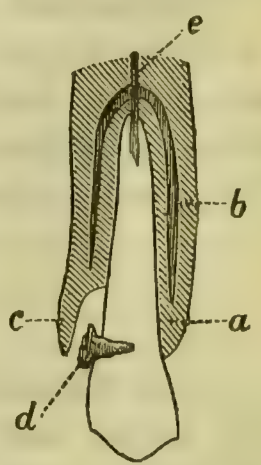

Fig. 6.—Diagram representing the detachment of the gum (*c*) from the neck of a Tooth, and the intrusion of tartar (*d*) into the pond thus formed. *e*, nerve; *b*, bony socket; *a*, edge of gum.

The teeth should, of course, always be kept scrupulously free from tartar, both because it renders the breath unpleasant and is uncleanly, and because it tends towards the starting of the diseased condition just alluded to.

As general directions for the care of the teeth, the following may be given :—

The teeth should be thoroughly cleaned at least twice a day with a brush of only moderate hardness; and if the teeth are inclined to decay between, or there are fillings between them, floss silk should be carefully passed through, so as to thoroughly cleanse the surfaces. Any place where food habitually lodges, and whence it is not promptly removed, is quite sure to decay sooner or later; and, on the other hand, teeth rarely decay on a fully-exposed surface. And from what has been said before, it will be readily seen that the most scrupulous cleanliness is the best of all preservatives for the teeth, and that the more delicate they are, the greater the need of frequent and thorough brushing—a thing which can hardly be overdone, although it is possible by the use of excessively hard brushes to inflict some injury upon the gums, and to drive their thin edges back from the necks of the teeth.

A tooth powder should fulfil two requirements : it should be soapy, so as to remove the viscid mucus of the gums, and it should be a fine polishing powder, free from gritty particles which could cut into the teeth. These requirements are sufficiently met by a powder composed of precipitated chalk, with which some dried soap has been combined, and the mixture agreeably scented. In special conditions of the gums other medicaments may be added, but this is sufficient for healthy mouths.

When acid medicines are being taken it is a good plan to wash the mouth out with an alkali, which can be conveniently done by adding a teaspoonful of carbonate of soda to the contents of a water bottle. The various salts of iron stain the teeth, but unless given in an acid form, do not attack them, and the stain can easily be subsequently removed; indeed, it may be said that medicines often get accused of doing mischief, which is more truly due to that state of health which the medicines were given to correct.

Gums that are inclined to being spongy are much benefited by brisk rubbing with the fingers, and astringents may be at the same time rubbed in, such as tannin, or myrrh. And where there are unpleasant discharges from about loose teeth, or from the sockets of freshly extracted teeth, or from abscesses, diluted Condy's Toilet Fluid will be found both efficacious and agreeable to use.

The Care of the Teeth in Childhood.

The formation of the permanent teeth commences very soon after birth, so that the health and the nourishment of the child in early infancy have much to do with their character. The process of cutting the first teeth is one very often accompanied by serious constitutional symptoms, which are sometimes alleviated by measures such as lancing the gums, although the disturbance is often too far reaching to be dealt with by treatment so simple; but the use of teething powders and the like should be absolutely forbidden for the reasons given above, if for no other. Irregularity in the position of the first teeth is very rare indeed; and it is often not worth while to fill them when they decay, as their tenure is so short; it is unusual for them to ache severely or constantly, and the application of a drop of oil of cloves on wool will generally be found efficacious in relieving pain arising from them.

By the age of six and a half years the jaws should have grown to such an extent that small spaces exist between all the first teeth in the front part of the mouth. The first to be changed are the central lower incisors; then follow the lateral incisors; next the central upper incisors. It very often happens that the first teeth are not shed in time to get out of the way of their successors, and in this case they should be removed, because a very slight resistance is adequate to turn a coming tooth out of its proper position. About this same time a new tooth, the first permanent or "six-year-old" molar, comes up quite behind all the temporary teeth, none of which does it displace, so that parents often are unaware that it is a permanent tooth at all. They are particularly prone to decay, so that a watch should be kept upon these teeth, lest they should be allowed, as is too often the case, to get hopelessly damaged before aid is sought.

Irregularities may be roughly divided into two groups: those in which individual teeth are displaced, although situated in a jawbone of normal dimensions and form; and those in which teeth and jaws alike participate in the irregularity of size or position.

In the first group it is seldom necessary to extract any permanent tooth to give space, but in the second it is very often necessary to do so. The growth of the jaw being pretty fully understood, it is possible to decide very early whether there will or will not be room for all the teeth. And it may be mentioned here that the idea that extraction of temporary teeth may lead to contraction of the jaws is an utterly fallacious one: the forming permanent teeth in their bony cells occupy much more space than the wasting roots of the first teeth.

When the new teeth are irregular a competent opinion should be sought early, for some forms of irregularity will correct themselves; others can be best and more speedily corrected very early; whilst others again cannot be advantageously treated till all the teeth have been changed.

It is a curious fact, well illustrated in the various breeds of dogs and of cattle, as well as in man, that variations in the size of the jaws are much more easily brought about than variations in the size of the teeth. Thus, a short-muzzled dog has his teeth crowded; a long-muzzled dog has them well spaced; and a child with a tapering, oval, refined type of face, and small jaws, often has the teeth appropriate to a much heavier development of that region of the face. Hence, its teeth are crowded tight against one another and pressed out of line, and ultimately the wisdom-teeth are stunted by the want of space for their development and eruption.

There are two ways in which the trouble may be met: the whole arch may be somewhat expanded by the use of plates, or teeth may be taken out, so as to afford space by there being a smaller number to be accommodated. The choice between these courses is largely determined by the aspect of the face—whether it will gain or lose by the expansion of the arch, and also by the character of the teeth, for if they are not of the very best type, or if they show the least sign of interstitial decay, they cannot afford to be exposed to the danger of crowding, and judicious extraction will save many a visit to the dentist, and the loss of many a tooth.

THE SKIN AND HAIR.

By Malcolm Morris, F.R.C.S., Ed.,

Surgeon to the Skin Department of St. Mary's Hospital.

Structure of the Skin—Functions of the Skin—Baths and Bathing—Cold Bath—Hot Bath—Soap—Turkish Bath—Conditions that Influence the Health of the Skin—Poisonous Dyes in Clothing—Cosmetics—Hair in History—Structure of Hair—Management of the Hair—Baldness—Hair-dyes—Nails.

The Structure of the Skin.

Simple as the human skin may appear to the superficial observer and to the unaided eye, science and its ministering appliances, in revealing and explaining its texture and construction, prove it to be a complicated organ, fulfilling other important offices, besides the obvious purpose of envelope to the many delicate structures consigned to its protection. There are three convenient divisions under which the subject may be considered. These are:—the skin proper; the glands found therein; and the appendages, hair and nails.

Skin proper.—The outer surface of this, which is dense and hard, is called the cuticle or scarf skin. Some writers when treating of the skin in its two chief divisions—viz., the upper or epidermis (*epi*, upon, and *derma*, the true skin), and the under derma—apply the term scarf skin to the entire epidermis, but it is here limited to its top surface only. This scarf skin is composed of scales or flat plates, lying in layers that vary in thickness with the skin—*i.e.*, very thin on the eyelids and portions of the ears, and thickest on the sole of the foot and the palm of the hand. These scales it is that are shed in large masses after any severe inflammation of the skin, such as takes place in scarlet fever. Beneath the scarf skin, or hard layer, is a soft or mucous layer consisting of about half a dozen rows of small bodies called cells. These cells placed side by side, like bricks in a wall, are retained in position by a semi-fluid substance, known as cement, which fills the intervening spaces and holds the cells together.

The cell itself is of peculiar construction, resembling a minute network rolled up into a ball, in which, when viewed under the microscope, a kind of black spot is observable. This appearance is due to the network being denser at such point (which is called the nucleus) than in the general substance of the cell. In the meshes of the network of some of these cells, especially those of the lowest row, minute particles are seen, called pigment. When these particles are numerous, and are present in each cell of a row, the result is naturally a dark line. A series of such lines viewed from without, through the scarf skin and the upper portion of the mucous layer, convey to the naked eye a uniformly dark impression.

This is the case with the skin of the negro. The less the number of these particles of pigment or colouring matter, the lighter the tint of skin, graduating from the swarthy negro, through the brown, olive, and blonde, to the colourless albino, who is entirely devoid of pigment in skin, eyes, and hair. The rays of the sun, a mustard plaister, in fact heat in any form, or indeed irritation without heat, such as a blister, will increase this pigment. Even through his thick clothing the furnaceman's skin, exposed to intense heat, though shielded from light, becomes completely bronzed.

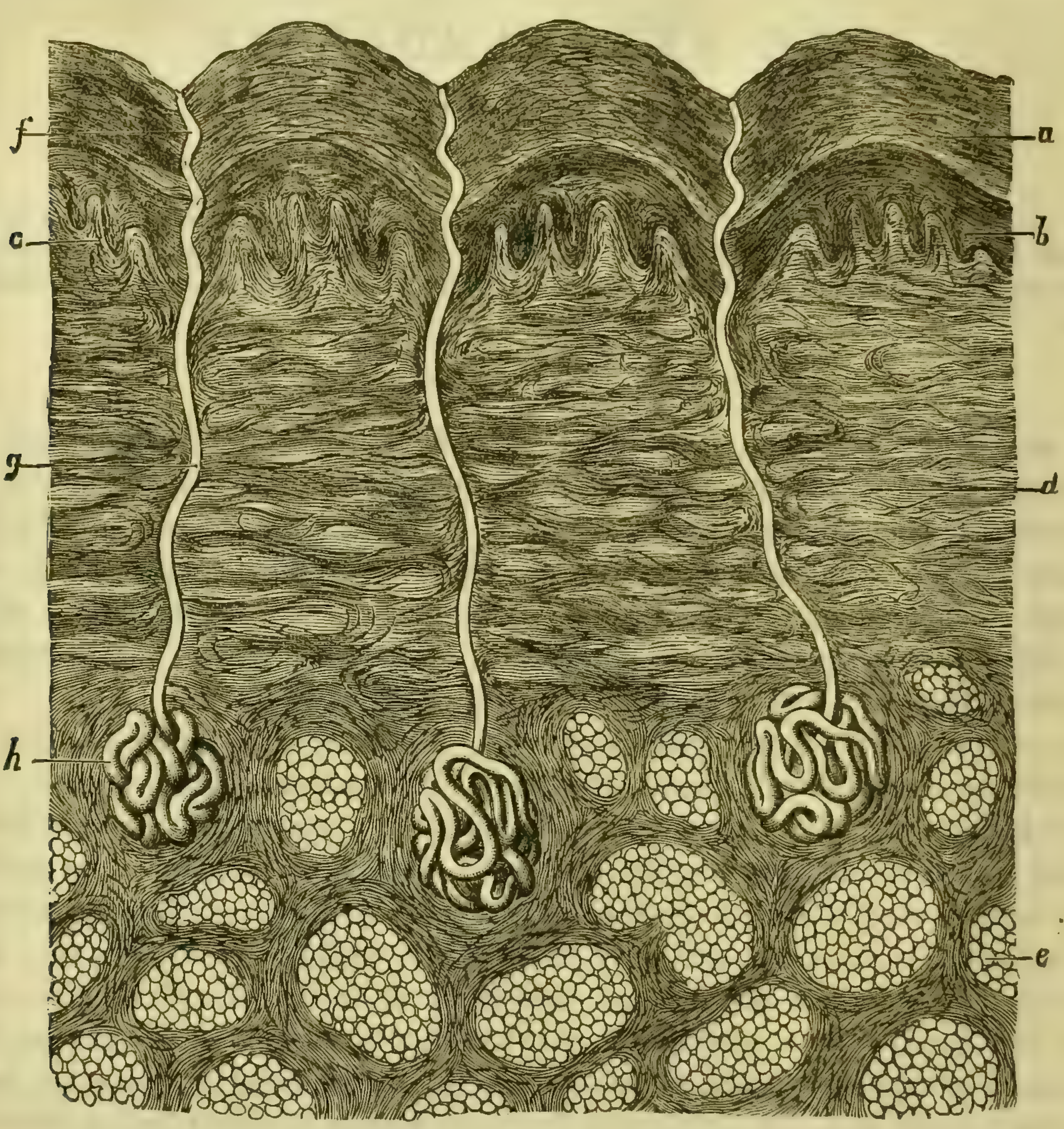

Fig. 1.—Section of Skin.

a, Scarf skin; *b*, soft layer of epidermis; *c*, papilla of true skin; *d*, true skin; *e*, fat; *f* and *g*, tube of sweat gland; *h*, body of sweat gland.

The mucous layer serves to manufacture fresh scarf skin as fast as the old is worn away by friction. Deeper in this layer the network of one cell will be found to extend itself on all sides to its neighbours, interlacing with them, so that in a thin section an appearance somewhat like a rope ladder is seen between the cells. In the deepest layer the cells are longer and narrower than those above, and are arranged side by side, in a kind of palisade, thus completing the epidermis or exterior layer of the two great divisions. We have contented ourselves with describing this division as consisting of two layers only, the scaly and the mucous.

As a matter of fact, there are two other layers, but they are not of sufficient importance to call for mention here. It has been the practice to point out the distinction between the epidermis and the true skin or derma by instancing the effect of a blister, the bleb raised by which is punctured, the fluid dispersed, and the film removed by means of scissors. And because the red surface thus laid bare was tender to the touch, it was the custom to call it the true skin. This is misleading. The film does not contain the whole of the epidermis, nor is the exposed sensitive surface its removal displays, the derma, but a portion of the mucous layer. The tenderness experienced is due to the presence of minute delicate nerves that thread their way from the derma beneath, into the cement substance between the cells we have spoken of, dividing and re-uniting in all directions. When we reach the functions of the skin, we shall have to refer to this point again.

The epidermis and the derma differ essentially in structure; the former being composed of scales and cells, and the latter of much more complicated materials. We have said that the epidermis is thicker in some parts of the body than in others, as, for instance, in the hands and feet. Friction, by stimulating the cells to increased action, tends to the production of a greater quantity of scarf scales; hence, the horny masses on the hands of the cricketer, oarsman, and lawn-tennis player. The workman's hands are covered with these evidences of labour. But there are other features. The skin on the inner surfaces of the joints appears scored in all directions with grooves and furrows, which are the folds and creases produced by its movements. The thickness of the scarf skin has much to do with regulating the depth of these, the lines on the open hand being deeply defined, whereas those in the elbow joint vanish when the arm is straightened. As to the permanence of these indentations, that will depend much on the elastic quality of the skin. Daniel Turner, writing a hundred years ago, mentions the case of a young Spaniard in the hospital at Amsterdam, who possessed the power of stretching the skin of his chin down to his breast or up to his eyes, that of his shoulder up to his mouth, that of his knee and leg so as to reach his foot. In youth, the natural elasticity is at its best, and lines and wrinkles are very speedily effaced. As years increase, and health declines, they leave their marks behind them.

But besides the folds and creases of the skin, there are visible to the naked eye, not only on the hand, but on other parts of the body, multitudes of smaller furrows alternating with ridges, giving the appearance of a ploughed field. These are formed by what are termed the papillæ, or minute projections on the undulatory surface of the true skin, or derma, which fit into corresponding elevations and depressions in the mucous layer of the epidermis we have been describing. The papillæ, which are invisible to the naked eye, are of two kinds—simple and compound—and of different sizes. The smallest are found on the face, a larger size on the palms of the hands and soles of the feet, and the largest of all under the nails. They have rounded ends, and belong to the simple variety. The fine wave-like lines noticeable on the hands and feet are produced by ridges of compound papillæ, some having as many as four points from one stem, ranging in double rows. In the extremely narrow grooves between these rows lie the openings of the sudoriferous or sweat glands, the tubes of which take a spiral form as they pass from the true skin through the epidermis. In the hand, where this is thick, as many as ten turns of the spiral have been counted, and fifteen in the feet. It is the true skin, or derma, of animals that, when stripped of hair and tanned, is converted into leather, the papillæ giving it the irregular and uneven surface with which we are all familiar. According to Sappey, the extent or area of the skin in a man of average size is equal to about twelve square feet, and in a tall man it may be as much as eighteen square feet.

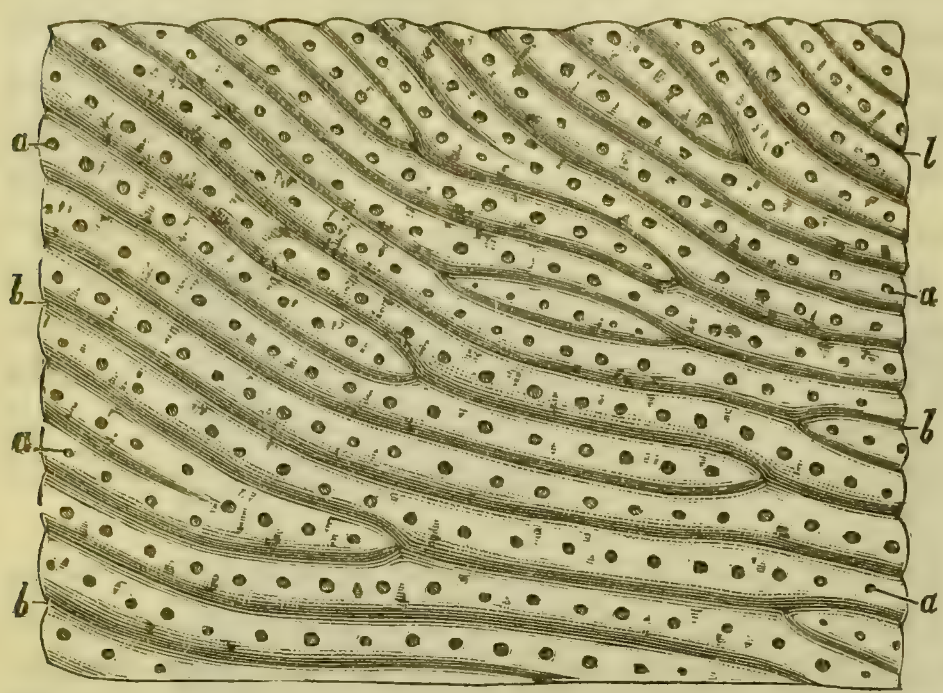

Fig. 2.—Sweat Glands of the Palm of the Hand, viewed from the Surface.
a, Mouth of sweat gland; *b*, ridge.

The true skin varies in thickness from one-twelfth to one-eighth of an inch. When we speak of people as thick-skinned and thin-skinned, we are referring rather to their moral or mental condition. The expression admits, however, of a physical rendering. It is, perhaps, apparent that the skins of women and children are thinner than those of most men. But in adults there are certain differences in the thickness of the epidermis which we find associated with the varying degrees of colour of the hair and eyes. Generally speaking, thick skin accompanies black hair and dark-brown eyes; medium goes with the brown hair and light-brown or blue-grey eyes; and in those having light, auburn, or flaxen hair and grey eyes, the skin is thinnest. In this last class the epidermis is so transparent that the blood circulating beneath it imparts a tint of great beauty. But we must pass on to the true skin, which constitutes in every sense the most important part of the organ.

The True Skin.—The Derma or Corium.

This is composed of a marvellous framework for the reception of all kinds of living apparatus. In it ramify the vitalising tubes called blood-vessels and lymphatics, the wondrous telegraphic system of nerves, the oil and sweat glands, and the hair sacs; also the little bags or receptacles for fat.

The framework itself consists of fine fibres, interlacing so as to form a tough but elastic substance resembling felt. Near the surface, these fibres are delicate and compact, but as they get deeper they become coarser and less dense, affording spaces for the glands, and also for certain small cushions of fat. It is this fibrous substance in animals that, when boiled, forms the jelly commonly known as gelatine. The familiar dish, tête de veau bouillée, may be cited as an illustration.

Here again, as in the epidermis, a semi-fluid, which in life is probably quite fluid, will be found, filling up the interstices between the fibres, and in direct communication with the cement which binds together the cells of the epidermis.

Blood-vessels.—The little hills or papillæ, of which we have spoken, consist of fibres similar to those composing the true skin, and in the centre of each is the termination or loop of a blood-tube, and in some a peculiar ending of a nerve. In the skin, as in other parts of the body, there are two sets of tubes, the blood circulating in one set, and a fluid called lymph in the other. But perhaps the best way to understand these vessels in relation to the present inquiry, is to glance briefly at Harvey's great discovery, the circulation of the blood. Indeed, so intimately is it connected with this part of our subject, that to take the reader further in ignorance of so important a factor, would be equivalent to speaking to him in an unknown tongue.

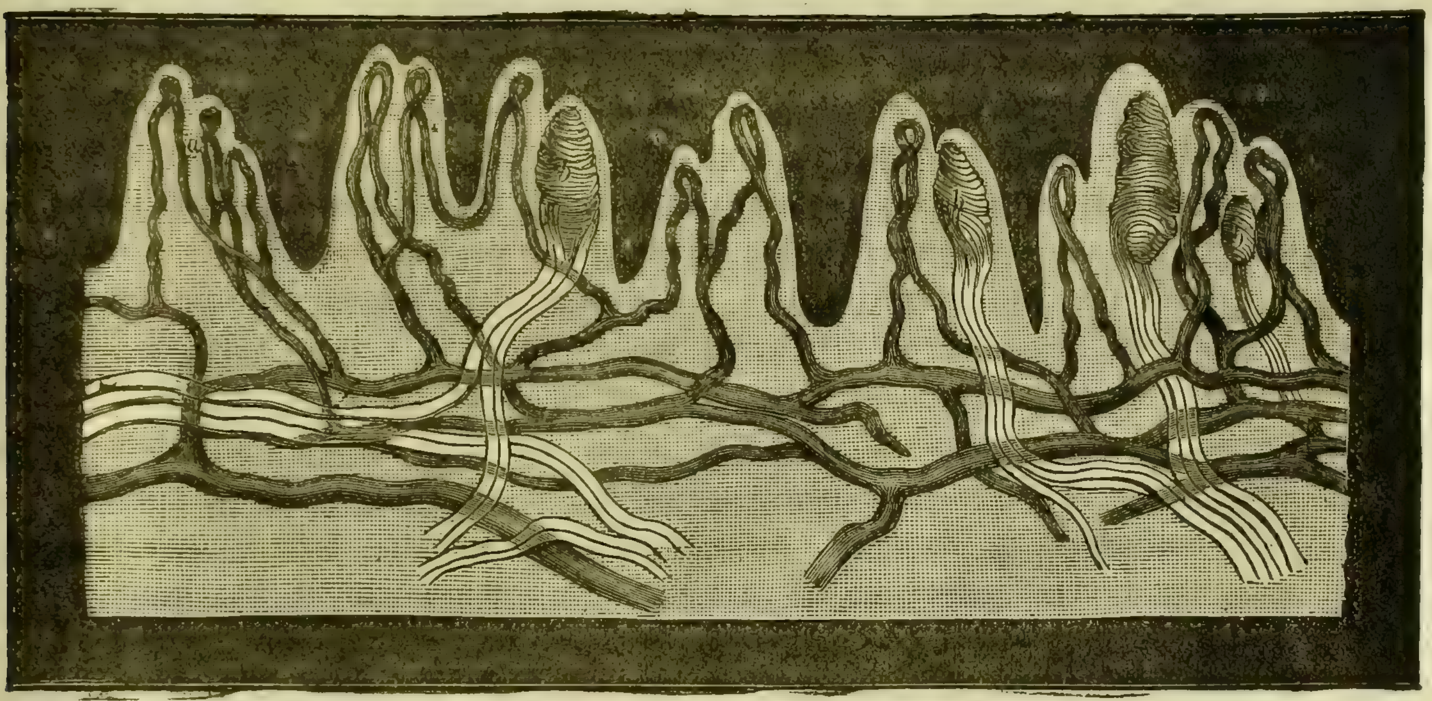

Fig 3.—Diagram of Papillæ, showing (*a*) Loops of Blood-vessels and (*b*) Endings of Nerves.

Starting on its journey from the heart, the blood enters certain large tubes called arteries. It is bright crimson in colour, and rich in the possession of a gas, termed oxygen, that has the power of giving life to the tissues of the body that it feeds. The arteries, gradually diminishing in size as they get further and further from the heart, become by the time they reach the under surface of the skin, quite small. Here they form a network, from which other still smaller branches strike off with different destinations. One set passes outwards towards the surface of the true skin, ending, as we have said, in the little hills or papillæ; another to the glands of perspiration, and others to the oil glands, the roots of the hairs, and the receptacles of fat. Arrived at these various parts, they are once more split up into even smaller tubes, named capillaries, which embrace most completely, as with a network, the organs we have mentioned. Other vessels, the veins, now come into action. By them the blood is collected from the capillaries, and carried off on its return journey to the heart. Gradually the small tributary veins become merged in others which increase in size as they decrease in number, till they at length reach the heart and deliver the blood. Thus the circuit is completed. In this beautiful scheme the desired object is attained most perfectly, for the only way to bring the blood into direct contact with the tissues, is by thus dispersing it uniformly and freely throughout their surfaces. And this is a necessity. Just as the farmer irrigates his land by means of small channels, carrying water for the nourishment of the crop spread abroad upon the fields, so do the innumerable minute vessels situated in the skin, bear to its every part the vivifying and regenerating influences of the blood. In order to facilitate the action of this circulating medium upon the parts with which it comes in contact, the walls of the capillaries are extremely thin; and in this way the purifying gas contained in the blood is able to pass through them into the tissues, and the impure gas in like manner passes out into the blood. Thus, the tissues are nourished by the oxygen brought to them, and relieved of their impurity, carbonic acid. But this is not all the benefit the skin derives from the blood.

Lymphatics.—Besides the oxygen, some of the fluid matter of the blood also makes its way through the thin walls of the capillaries, and this is collected and carried off by the other system of tubes called lymphatics. These begin, not in tubes, but in the spaces between the fibres which form the true skin. Thus, the lymphatic tubes are drains for the surplus fluid. Between the lymphatics and the blood-vessels in the skin, some specific relation would seem to exist; for although the larger vessels of each system, throughout other parts of the body, are independent of each other, in the region of the capillaries, one and occasionally two of the tiny blood-vessels will be found accompanying a lymphatic tube for a considerable distance, and embedded in its wall. In the skin of the frog two lymphatics, says Langer, accompany the larger blood-vessels. In some parts of the human skin, the lymphatics are accompanied by two blood-vessels, whose capillaries surround them. In addition to the normal tint we have already referred to as being determined by the pigment, there is the hue or colour it derives from the presence of blood, and which varies according to its amount. The blood-vessels being elastic sometimes dilate and allow blood to pass freely; at others they contract, and the vessels become empty or nearly so; in the one case the skin is rendered bright red, in the other pale.

Nerves.—The movements in the blood-vessels are under the control of the system of nerves, acting on the muscular coat of the vessel to which their minute terminations are attached. Through this telegraphic system of communication, the brain receives intelligence and issues its instructions to all parts, regulating the action of the muscular coat of the blood-vessels, and producing at will an effect, either sudden or gradual, of now a contraction and now a dilatation. Thus, a thought can close the vessels and blanch the cheek, and by opening them suffuse it with a blush. But there are two kinds of muscular tissue in the body—the one under the control of the will, the other not. The muscles of the arm can be moved at pleasure, whereas the little muscles in the blood-vessels will not yield allegiance to our will; they obey our thoughts and emotions. When, indeed, as in some rare cases, thought can be brought into subjection to will, we have the marvellous phenomenon of a voluntary blush, or the still greater feat of an assumed pallor. Involuntary muscles occur in other parts of the skin, independent of the blood-vessels, and by their contraction cause that curious appearance known as "goose skin."

In the mucous and horny layers of the skin there are no blood-vessels, but as the nerves extend into the cement in the former, if for instance, by grazing the surface, they become exposed, the capillaries beneath, deprived of support, become crushed and lacerated by the actual pressure of the blood, some of which oozes out of the living part (or quick), and instantly the nerves telegraph the news to the brain that the part is in pain. This, then, is all produced by the nerves informing the brain of local injury; and if, as when chloroform is used, the brain be deadened and deprived of the power of comprehending the message, no pain is realised or felt. The telegram has passed along the wire, but the receiving machine is out of gear. It is as sound to the deaf; it signifies nothing. In order to increase the sensitiveness of the epidermis, some nerves are formed so as to branch off in minute threads throughout the cement substance of the mucous portion, while others become enlarged or thickened, and those located in the papillæ are supposed to give rise to the sense of touch. The palms of the hands are profusely endowed in this respect.

We have spoken of the nerve as a thread, but it is more complex than this. Our analogy of the telegraph is more appropriate; for, in reality, each nerve consists of a bundle of threads, and every thread has a different duty to perform. Under the microscope, a nerve cord appears split up into separate strands—a bunch of wires, so to speak, such as one sees on the pavement when a subterranean telegraph is being repaired. Some transmit the sense of touch, or report to the brain the local experiences of heat or cold, and back in turn come instructions by other nerves bidding the muscles contract, and so remove the part out of the way of such influence. The selection of suitable nourishment for the various parts of the body is entrusted to an entirely different set of fibres, while others again communicate with the sweat and oil glands.

Sweat Glands.—As the blush is produced by the nerve acting on the blood-vessels, so profuse perspiration which accompanies fright is due to a similar operation by the nerves upon the sweat glands. Nearly every part of the skin is furnished with these important glands. They consist of tubes with very thin walls, and are lined with cells, in appearance somewhat similar to those forming the deepest layer of the mucous portion of the epidermis. The secreting part of the gland—the part in which the sweat is formed—lies in the deeper part of the true skin in the large meshes of its framework. As will be seen in the diagram, the ball or substance of the gland below has a tube leading from it to the surface. If the ball, which is composed of tube coiled into a mass, be unwound, it would be found to be more than twice as long as the skin is deep. As the tube passes upwards, its structure changes, ceasing to have any special formation when it reaches the mucous layer of the epidermis. Here, therefore, the sweat has to wend its way between the cells of the epidermis, and forming for itself a spiral passage (before referred to) through the different layers, at length emerges by an oblique slit-like opening at the surface. This arrangement acts somewhat like a valve, and prevents the sweat flowing too rapidly, or returning into the tube when once forced out.

Oil Glands.—These glands, technically called *sebaceous*, because the oil they secrete is called sebum, somewhat resemble the structure of the sweat glands, but they are larger and more complicated. Unlike those of the sweat glands, the tubes are in most instances short and straight, of larger calibre, and pass direct to the surface of the skin, or into the hair sac at or near its mouth.

THE FUNCTIONS OF THE SKIN.

The functions of the skin are sevenfold. 1. It is a protection to the external surface of the body, and a support to the internal organs. 2. By means of its elaborate network of nerves, we obtain sensations of touch, pressure, temperature, and pain. 3. It regulates the temperature of the entire body. 4. It secretes sweat, and sebaceous or oily matter. 5. It is an organ of respiration supplementary to the lungs. 6. It is capable of absorbing into its lymphatics and blood-vessels some substances that may be brought into contact with its pores. 7. It acts as a purifier of the blood, an office in which it assists the kidneys, lungs, and intestines.

Protection and support.—That the skin protects the external surface of the body, is a fact too obvious to need demonstration. On the other hand, the support it affords to the internal organs is not so apparent. If the skin were to be removed from a man in the same way that it usually is from animals, that is, by cutting it free at the rims of the openings into the body, such as the food passage or alimentary canal, there would still remain, after the whole external skin had been taken off, an internal, but much looser coating of skin, more delicate in quality, lining the organs contained within the body. For at the apertures in the body where the external skin seems to end, and where the mucous membrane begins, the epidermis in reality continues covering and defending that membrane on its way to the interior of the body, although, owing to its extreme attenuation, it is not easily recognised as epidermis. Another name, in fact, is given it at these points where it begins its burrowings, and by this name, epithelium, it becomes thereafter known throughout the internal cavities which it lines. Beneath this epithelium runs the mucous membrane embracing the internal organs, and though of greater delicacy, it corresponds in every way to the derma of the surface skin as the epithelium does to the epidermis. Hence, as Huxley puts it, "every part of the body might be said to be contained between the walls of a double bag, formed by the epidermis which invests the outside of the body, and the epithelium, its continuation, which lines the internal cavities." Here, then, we have a framework with ramifications affording between them not only protection to the external, but also support to the internal, structures of the body.

The natural covering of man seems to vary much according to his condition and requirements. Our skin has not the same toughness as the skin of the savage, unclothed Indian. The downy hair delicately sprinkled over the surface of our bodies does not afford the same protection as that on our heads. It is not any longer a protective garment with us ; yet even comparatively recent evidences of its capacity in this respect are not wanting. In 1852, a Swiss woman having thick hair on her face and body, was examined at Charing Cross Hospital, and afterwards exhibited in Piccadilly. A French lady, after a fever, had her entire skin affected by that peculiar condition called "goose skin," the papillæ of which developed hairs an inch long over the whole surface of the body except the face, palms, and soles. A man was seen in Burmah, in 1829, completely hairy from head to foot. On his face, ears, and nose, the hair was eight inches long, and on the breast and shoulders four or five inches. Many other instances have been recorded; but it is not necessary to multiply them here, as the only object in mentioning these developments is to show that human skin is not limited to that delicate phase merely which our clothing covers. And again, the structure of the skin—with its system of drainage into the free air, whence as a minor lung it absorbs oxygen—with its nerves dependent for stimulus on the friction of the air, seems to assert the intimate relation man should maintain with the external world, and to point to the fact that nakedness is his natural and designed condition. The ancient Britons, who were unclothed, proved that even our climate with its many vicissitudes, could be endured in such circumstances by a people trained thereto from birth. Even much colder climates afford similar examples of the powers of resistance with which the skin is provided. The only garment of the inhabitant of Tierra del Fuego at Cape Horn is a hide hung over the windward shoulder, and the children wear nothing whatever, though their country is far colder than ours. All this seems to show that the human skin, when unassisted by external coverings, is capable of developing powers of self-preservation to meet all conditions of life.

Sensations of Touch, Pressure, Temperature, and Pain.—In the simplest forms of vitality, or lowest protoplasmic organisms, as they are termed, such as the living jelly we have mentioned, stimulus applied to the exterior causes contraction, local or general, in proportion to the force employed. Irritation of the outer layer of the medusæ, or jelly-fish, produces local contraction, and the tentacles, or stinging processes round the mouth, turn towards, and are often applied to the spot touched. Here impression is passed on from cell to cell, from periphery to centre; certain spots in the margin of this creature are found to be more sensitive than others, and although no structure of nerves has yet been made out, impulses travel most readily in particular directions. By this intercellular communication, which appears a very primitive method, a message is conveyed, as by a cordon of men passing the word one to another. Hence, the resulting movement, or quiver, is the sum of the contractions of individual cells. Human nerve filaments, on the other hand, would seem to have their analogy in the telegraph wire. But it is probable that a more refined analysis of both nerve and electric force will reveal that, as with light and sound, they are transmitted from molecule to molecule. If so, the seeming contrast between the cellular and nervous contractions will be resolved into an identity.

When, however, we get higher in the scale of development, we find that there is division of labour; the outer cells of the organism have become more specialised, so as to fit them to receive and originate impressions, and proportionately less contractile.

Processes from them serve specially as transmitters to the other cells in the interior, which are devoted to contraction.

In a still higher development of nerve tissue, division takes place in the outer cell, one portion being devoted to receiving and transmitting impressions from the exterior, while to the other and more internal portion is allotted the duty of collecting, modifying, and co-ordinating, before transmitting them to the muscle cell.

In the skin of mammalia, the horny layer serves as a protection to the more delicate mucous or rete layer, in which nerve filaments ramify ready to receive impressions from without. These, when communicated, are passed on to special sensory centres, where changes are set up which give rise to consciousness. The nerve filament is, as before stated, the exact counterpart of the telegraph wire. The transmitter records a message given in at the end organ, by movements which are reproduced in the receiving instrument, and there translated into consciousness. Stimulus applied at a point in the course of a nerve produces only general and indefinite sensation, usually pain. Exactness of perception is entirely dependent on the integrity of the nerve end, whereby the sensation is referred to the peripheral parts whence the nerve comes—*e.g.*, in striking the ulnar nerve, or so-called "funny bone," in the elbow. For exact sensations of touch, temperature, and pressure, end organs are indispensable. These are severally affected by—(1) Mechanical stimuli, corresponding to sensations of touch; and (2) Thermal stimuli, corresponding to sensations of temperature.

Sensations of Touch.—By means of what is called tactile sensibility, we obtain knowledge of external form, properties, and position of bodies, enabling us to test information gained from other sources. For instance, the child sees a bright object, and stretches out the hand to touch or grasp it; touch verifying or modifying the impression of distance gained by sight. When an object is pressed gently on the skin, the nerve filaments are stimulated, and the result is what we call the sensation of touch or pressure. Successive impressions are perceived as distinct one from another so long as the number per second does not exceed 1,500. When this number is increased, one continuous impression only is produced. Sensibility varies in degree in different parts of the body very considerably; is different in different persons; is increased by warmth, education, and practice; is decreased by cold and stretching of the skin. According to Weber, the distances at which two points can be distinguished as two, are smallest in the tongue (where they can be felt to be distinct when parted 1-24th of an inch), and greatest on the back and thigh (where the two points feel like one at any interval less than 2½ inches). The minimum of distinguishable distances is lower when the points of the compass are approximated from a clearly felt separation, than when expanded from sensible conjunction. It is also lower when one point is applied after the other, than when they both touch the skin at the same instant.

Sensations of Temperature.—These are perceived more readily the nearer they are to normal temperature and the more rapid the change of temperature. The sensations produced by the extremes of heat and cold are identical. Good conductors produce greater apparent effect of heat or cold than bad at the same temperature. Between 80°·6 and 89°·4 Fahr. is the range of the greatest accuracy of perception. The cheeks, eyelids, temples, and lips are more sensitive than the hands. Hence the laundress tests the heat of her iron against her cheek. Of the two, slight cold appears to be more easily distinguished than slight heat.

Sensations of Pressure.—These are more vivid the more suddenly they are produced, and also when there is no pressure on the adjacent parts, the contrast being thereby heightened. Sensation is greatest at the beginning of the impress, after which it rapidly diminishes. When the intensity of any stimulus exceeds certain limits, it produces pain, which if resulting from irritation of the trunk of the nerve is referred to the extremities. This process is a conservative one, enabling us, by warnings which beget experience, to avoid injury.

Heat Regulation.—The temperature of the body is due to combustion. The amount of heat in man is kept at a mean of about 98°·6 Fahr., that produced by the consumption of certain products of food taken into the body being balanced by that given off by the surface of the body, and the air expired from the lungs, &c. The skin is the main regulator, 77·5 per cent. of heat being lost by it as against 14·7 per cent. parted with by the lungs. Heat is distributed all over the body by means of the blood. In order to keep up this heat, fuel is necessary, and this is supplied by means of food containing oxygen, hydrogen, carbon, and nitrogen. Just as the work done and heat given off by the steam-engine are in exact proportion to the fuel burnt, so is the consumption of food in the human body proportionate to the force the body exerts. The food passes into the body by the alimentary canal, fresh air by the lungs, with a slight assistance, as we have before said, from the skin. About nine-tenths of the dry solid food thus taken into the body leaves it in time in the form of carbonic acid, water, and urea. As these compounds are, on leaving the body, far more highly oxidised than those which entered it, and as oxygen is not given off by any organ, it is clear that all the oxygen we breathe passes off in them. The processes they undergo, from the time of their entrance to their voidance from the body, are very complex. It is, however, certain that the food is converted into blood, which is brought, in its passage through the lungs, into contact with the oxygen inhaled, and is so heated and maintained at a certain temperature, and propelled by the heart to all parts of the body by means of its system of vessels.

What this heat would be were there no other means of parting with it but by radiation from the skin, we see illustrated in cases of fever, where the perspiration, which should here be evaporated, is suppressed, and the skin remains dry. In health, where there is free circulation of blood through the skin and the evaporation of sweat goes on without interruption, the heat generated by combustion is kept lowered to a uniform temperature. But, as we have seen in examining the structure of the skin, there is also another regulator of the superficial circulation of the blood. The nerves in connection with the vessels come into play, causing them to contract with the cold, and to relax with moderate warmth. A low temperature lessens the supply of blood, and with it the heat at the surface, and lessens too the supply of moisture that is to feed the sweat glands; and when the external temperature is high, with an increase of blood comes an increase of moisture, and so we have a complete system of compensating adjustment. Again, in exercise, although owing to rapid combustion, much heat is produced, the temperature rises but little, because not only is the evaporation increased in proportion to the heat evolved, but as the result of more frequent respiration, an increased amount of heat is liberated by the lungs. The increased temperature of the body in ague, cholera, &c., may be due to either of two causes—*i.e.*, to increased production, or to decreased loss of heat as resulting from contraction of the cutaneous blood-vessels beneath a dry and cold skin. Conversely, great heat can be borne so long as the circulation be vigorous and sweating free. Gas stokers and engineers in the tropics are examples of this fact, for though they often lose by sweating from two to three pounds weight in one hour, the temperature of the body is not perceptibly raised.

Secretion.—Perspiration or Sweat.—In health, the skin gives out but a small portion of nitrogenous waste of body, but it eliminates some carbonic acid, a small quantity of salts, and a variable amount of water, which may be roughly estimated to fluctuate between four and forty pounds in a day.

The chief constituents of the waste products in health are: water; sodium chloride or common table salt, with a small amount of inorganic salts; fatty acids; neutral fats, and urea.

Insensible perspiration is that portion of the sweat which passes off in the form of aqueous vapour and volatile matter, as distinguished from the sensible perspiration that is visible as fluid on the skin. The proportion which one bears to the other varies with the surrounding conditions, and the seeming fluctuations are sometimes more apparent than real. Thus, when it is said that dry, hot, moving air promotes insensible perspiration, it is implied that these conditions encourage sensible perspiration also; for the rate of secretion remaining constant, dry hot air passing rapidly over the body, by evaporation of the sensible perspiration converts it into insensible perspiration, while the cool, moist, and stationary air causes the sensible perspiration to stand upon the skin. Often, therefore, when we seem to be perspiring profusely it must not be assumed that there has been an increase in the total amount of sweat, but that the moisture, which in a dry and hot air would have passed off unnoticed or insensibly, has remained chilled and visible on the surface of the body. Nevertheless, the rate of secretion itself is often so accelerated that no amount of heat, dryness, or motion of the air will suffice to evaporate it, in which case we have sensible perspiration in a dry, hot air; and this is certainly the way to account for it usually, for heat conduces to secretion, and so too, in all probability does dryness of itself merely. As regards quantity, that varies with the amount and quality of food and drink, and depends much upon the amount of exercise taken, the activity of other organs, and the influences of drugs, diseases, and mental impressions.

In appearance, sweat is a colourless, clear fluid, containing a few accidental epidermic scales, and 1·81 per cent. of solids, of which two-thirds are organic. In certain parts of the body—as for instance, the arm-pits—special glands secrete specially odoriferous matter. A similar provision is made in the lower animals, the odour being pleasant as in the civet, and the reverse as in the skunk and fox. Certain of the odours are said to be distinctive not only of particular races, but even of individuals. The Quichna Indians of Peru have been known to detect by this means, even in the dark, differences of race as well as of person. The blood-hound possesses similar instincts.

In health, the greater part of the nitrogenous waste is eliminated by the kidneys; but in disease, the skin, as well as the mucous membrane of the alimentary canal, partly replaces the functions of the kidneys. In particular diseases, the sweat is found to contain, sometimes pretty abundantly, blood, sugar, bile, besides iodine, arsenic, and other drugs taken internally.

Sebaceous Matter.—This matter, which consists of dried epidermic scales and oil, probably gives some of the odour to the sweat. As before observed, it serves to lubricate the hairs; to it also is due the shiny, oily look, noticeable in the skin of the negro. As a function however, it is of much less importance in man than in some of the lower animals. To all birds, aquatic in particular, it is indispensable; and, indeed, a special gland is provided near the tail, which is used to lubricate the feathers, thus rendering them waterproof.

Respiration.—As with the lungs, so in a lesser degree with the skin; in addition to getting rid of a great deal of vapour of water, oxygen is taken in and carbonic acid given off, the quantity of work thus done being increased by exercise and warmth. Important as this accessory function is to man, it is far more so to some of the lower animals. As evidence of the freedom with which the respective gases are absorbed and given out in the case of the frog, it may be stated that that animal will live for several days after the lungs have been destroyed. And, further, it is found that in many invertebrate animals, whether provided with special respiratory organs or not, the skin has similar functions. In man, respiration by means of the skin is much limited, owing to the thickness of the epidermis; experiments, however, have conclusively established the existence of this function.

For instance, if the body be enclosed in an air-tight bag or chamber fitting tightly round the neck, it is found on analysis that after a time the air has lost oxygen and become charged with carbonic acid: precisely, but in a lesser degree, what would take place in the same bag or chamber with proportionate rapidity if the mouth—and through it, the much larger organ, the lungs—had been enclosed instead of the body.

A striking illustration used to be quoted as evidencing the importance of this function—that of a little child, who, being selected to represent an angel at the coronation ceremonies of Pope Leo X., was coated with gum and then covered with gold leaf, and who survived the operation but a few hours. The symptoms, however, conclusively prove—whatever may be the explanation, and it is a complex question—that death resulting from arresting the functions of the skin is not due to asphyxia, or choking; it has much more the appearance of some kind of blood poisoning, and is accompanied by a great fall in the temperature of the body. Animals varnished or coated with paint die very speedily, but if wrapped in cotton wool, so as to raise the temperature, they invariably revive and often recover. The best authorities agree that the cause of death in such cases is the retention or re-absorption into the blood of some of the constituents of the perspiration; and in a measure, also, to the dilation of the cutaneous vessels, whereby rapid radiation of heat takes place even through the varnish.

Absorption.—It is doubtful whether substances dissolved in water can pass into the skin unless the epidermis be abraded; the balance of evidence seems to be against the supposition. The delicate skin of the frog will absorb water and soluble salts. In what is termed inunction, or rubbing into the skin, substances pass down into the sweat and sebaceous glands, and into the air sacs, where particles can be taken up by the surrounding protoplasmic migratory cells, and carried into the lymphatics, and so become altered and brought into soluble form. By whatever means access be obtained to the true skin, it is certain that, owing to its vascularity, absorption is very rapid—a fact that is constantly illustrated by the poisoned wound resulting from a mere scratch penetrating the epidermis.

Purifying Power of the Blood.—This function has already been alluded to in connection with that of secretion. It is naturally at its best in a state of convalescence, or during recovery from disease, when, in addition to the carbonic acid, water, &c. given out in health, it casts out all kinds of injurious products and waste material, the accumulation of which in the system would produce further mischief and retard recovery.

Baths and Bathing.

Accustomed as we have rapidly become to the comforts of a well-appointed bath, such as is to be found in all modern houses, we realise with difficulty that it was but rarely met with in houses built even forty years ago. Bathing in those days, and therefore, of course, swimming, formed no portion of the school curriculum, the gradual introduction of first one, and then the other, being among the salutary results of recent educational development.

The importance of the free use of water is perhaps best illustrated by its action upon those substances which habits of cleanliness alone will effectually remove. First of all, there is the dried-up epidermis, or scarf skin, to be got rid of; then there is the deposit of sweat and oily matter, to say nothing of the dirt and impurities derived from the air and the particles rubbed off from our clothing. The pores are only to a very limited extent self-cleansing. The scarf skin, if not removed by friction, in time obstructs the perspiration at the mouths of the glands, producing retention which interferes with the respiratory action of the skin. Next, as the result of the decomposition that ensues, the skin itself becomes first greatly irritated and then diseased, till, in the end, nature avenges the neglect by developing unsightly pimples and blotches. There are many agents for cleansing and relieving the skin, and so preventing these disagreeable consequences, but water and the frictional process that should accompany its use are the chief. Water, however, is a generic term embracing many varieties, some of which it may be well to consider a little closely.

There are two kinds of water which are commonly distinguished the one from the other, by the relative epithets, hard and soft. Absolutely pure water can be obtained only by the chemical union of its constituent gases, oxygen and hydrogen. Melted snow or hail, which has fallen in places removed from human habitation, and therefore contains comparatively few foreign ingredients, affords, perhaps, the nearest approximation to pure water. Rain water which, if collected in proper receptacles in country districts, comes next in point of purity, in all probability always contains ammonia in small quantity, combined with carbonic, nitric, and nitrous acids and organic substances. Distilled water is water which has been deprived only of its fixed and non-volatile constituents.

Experience has shown that in not a few cases, the soluble salts in the water used for personal ablution, are a fertile source of irritation and injury to sensitive skins. In some instances the mere substitution of boiled water effects a sensible reduction in the roughness, or other discomfort; but it often occurs that only distilled water will give complete relief, so inimical are the ingredients of hard water to delicate complexions. Boiling will not wholly remove these objectionable substances, whilst the other methods which will be referred to for softening water, are inconvenient and impracticable in private families. The purest water, and that best adapted for general use in cleansing the skin, is undoubtedly distilled water. The comfort, to say nothing of the great saving in soap, would have made it by this time an essential for the toilet, but for the difficulty of obtaining a sufficient quantity of it at a reasonable price. Now, however, by the aid of a very simple but ingenious device, every householder possessing a boiler to his kitchen-range may obtain it for himself, the amount yielded being dependent upon the size of his boiler. The advantage to the medical practitioner and chemist of obtaining distilled water in their own houses is self-evident. At present a waste-pipe, commonly known among builders as a "blow-pipe" or "blower," is attached to all kitchen-boilers, whence it is carried into the chimney, and serves as an outlet for the steam which is constantly being generated, and would otherwise burst the boiler. The kind of pipe generally employed for the purpose is new iron gas-pipe. The steam, however, which is thus being perpetually wasted needs only to be captured, condensed, and retained in a suitable vessel, to provide us at once with an article which will not only effect a great saving in soap, but also render the cleansing of the skin a positive luxury. There are, of course, many ways of condensing this steam, and collecting the resulting distilled water, but an ordinary kitchen-boiler, supplied with a common spiral tube to carry it to some cool situation, where it will readily condense, will supply distilled water, which there and then becomes available for any purpose, either domestic or medicinal.

The substances that water will not, to some extent, dissolve are few; and hence it is that metals, such as silver, lead, and copper, can be detected in sea-water. This great solvent property of water explains how it is that spring, river, and well waters hold in solution certain solid substances derived from the soil through which they pass, as well as particular gases. The solid matters most largely predominating in these waters are the carbonates, sulphates, and chlorides of soda, lime, and magnesia. The gases, except in rare cases, are carbonic acid, oxygen, and nitrogen. *Hard* waters, so called, are such as contain an excess or large quantity of salts of lime and magnesia. Those, on the other hand, from which these salts are absent, or nearly so, are termed *soft* waters. Amongst hard waters may be classed those supplied by the Metropolitan water companies, in which are present about twenty grains per gallon of salts of lime and magnesia. Examples of soft water are afforded by that from Loch Katrine, in Scotland, containing in the gallon a scarcely appreciable amount of these ingredients, and that of Bala Lake, in North Wales, in which there is less than a quarter of a grain of lime and magnesia salts per gallon. Carbonate of lime held in solution by carbonic acid is, for the most part, the hardening ingredient in the waters of the London companies. These waters can be rendered softer by boiling, which process, driving off the carbonic acid, converts the previously soluble lime salt into an insoluble one, which falls to the bottom of the vessel, and may be removed from the water. The deposit on our kettles and boilers which has been formed in this manner is chiefly insoluble carbonate of lime.

Another process for softening water, the invention of Dr. Clark, of Aberdeen, consists in adding lime water to the hard water. The results are the same as when it is boiled. The lime, seizing the free carbonic acid, becomes converted into an insoluble carbonate, which is precipitated. In some waters, the hardness, instead of being due to the carbonates, is caused by the presence of the sulphates of lime and magnesia. To remove these, a small quantity of ordinary washing soda should be added until the water ceases to appear milky. This clearing of the water indicates that the sulphates have been precipitated as insoluble carbonates. Washerwomen constantly adopt this method of softening water. It is, perhaps, well to point out that such treatment renders it unfit to drink. By way then of summarising the various kinds of water, we may say that distilled and rain water are softest; next in order comes river water; and, lastly, that obtained from natural springs.

From a knowledge of the ordinary ingredients entering into the composition of different waters, it was for a long time accepted as indisputable that when used in baths the water and its contents were capable of being absorbed through the skin. Indeed, when Abernethy and others first began to make careful experiments of this supposed property of water, it was not with a view to test what was already considered a settled question, but in order merely to ascertain its method and measure, the known perviousness of the skin to the ingredients of ointments having led to the supposition that it was accessible to water in like manner. Abernethy's experiments conclusively proved that gases were absorbed in this way, as also sulphuric ether and oil of turpentine, though with these latter some chemical change was observable in the structure of the skin. All these were found to be capable of penetrating not only living but isolated epidermis. Salt, also, was at first thought to do so, because indications of it were traceable in the excretions after a brine or sool-bath, as it is called; but it was afterwards held to have made its way through abrasions in the epidermis to the true skin, which is well known (as before explained) to possess powers of rapid absorption. Krause, experimenting at the same time, was successful in procuring the absorption of concentrated solutions of acids, alkalies, and nitrate of silver, and was thereby led to assert the permeability of the epidermis for all solutions, although he failed in getting like results when he used sulphate of copper, nitrate of potash, chloride of iron, and many other substances, including lead, sugar, gum, and white of egg. The truth is that, by reason of the obvious difficulties attending such experiments, it is well nigh impossible that any satisfactory results should be obtained. Everything depends on the accuracy of the weighing before and after immersion, and on the perfect drying of the skin so expeditiously as not to allow of any loss of weight from perspiration, which normally varies in different persons and at different times, so that no allowance could be determined to represent it. Lastly, no scales are trustworthy in detecting fluctuations of grains in the weight of a body as heavy as a man. The net result of all investigation on this point up to the present time is that the almost universal opinion has pronounced against the absorption of fluids by the epidermis. Perhaps the strongest of all the evidence in this direction is the negative one that if in sea bathing salt were absorbed the mischief to the blood could not escape observation.

The Cold Bath.—The salutary influences of the cold bath are not confined to its cleansing effects. These are quite of secondary importance beside its beneficent action as a tonic to the skin and internal organs. Professor Braun says :—"The more vigorous are a man's physical movements, the less need has he of ablutions for the maintenance of his health, partly because the continued friction of most parts of the skin and the perspiration produced by work are sufficient in themselves to perform the mechanical task of cleansing. Thus experience teaches that to the labourer baths and ablutions are less necessary than to the man of a sedentary mode of life, and to the adult than to the infant, whose lungs discharge their office feebly."

With regard to the cold bath, it may be well to say at once that it is not a tonic suited to everybody. Still less is it an agreeable sensation experienced for the first time by a man totally unaccustomed to the kind of thing. The skin is a delicate organ, and resents harsh treatment. The nerves must not be shocked too suddenly, or they become temporarily pained and dread every repetition of the process. When we say we shrink from contact with cold water we speak the literal truth, attested by every muscle in the body, acted on, as we have seen the muscles are, by the nerve fibres. The irritation should be gradual, commencing with water of a temperature that can be borne without discomfort, and then decreasing it. In this way only can some skins be brought to tolerate perfectly cold water. Beneath the mass of clothing usually worn in these days, the skin, utterly deprived of healthy contact with the air, becomes unnaturally sensitive to thermic influences. Like a hot-house plant, it feels the slightest exposure. Those who have steadily persevered, making concessions to its susceptibilities, without relinquishing the bath, know how soon and easily it may be strengthened to endure the coldest water the seasons produce. The normal temperature of the body is about 98° Fahr., and if the water used be even but a little cooler than this, the effect produced is the same in principle, greater or less of course in proportion to the coldness of the water used. Water is a far better conductor of heat than air. Hence, although air at 77° Fahr. would produce no feeling of cold, that temperature of water may be considered low enough to constitute a cold bath for most persons.

The first result of the shock to the sensitive skin is a shiver of the muscles. This sensation is transmitted by the cutaneous nerves to the brain, in consequence of which, as we have explained, the blood-vessels of the skin contract, the whole surface becomes pale and bloodless, and the temperature at the surface falls below normal. Drawn thus from the skin, the blood, which must go somewhere, has rushed to the large internal organs, whence, having gained an accession of heat, it will flow back again into the gradually recovering and dilating vessels of the skin. This return of the blood should be accompanied by a pleasurable glow, which it is the object of the whole operation to effect, and which should be further assisted by friction with a rough towel so as to increase the flow of blood to the surface of the body. Brief as this process may be, occupying possibly but a few moments, it is nevertheless a most active process. If instead of accustoming the skin to a shock by gradual training, its sensitiveness be disregarded, the superficial shock from the cold water is not the only result. In proportion to it will be the corresponding shock to the internal organs upon which the retreating blood must rush. If there be a weak point in any one of these, the congestion, due to the sudden access of blood, may prove most mischievous. Vessels that may be equal to a certain strain may give way if unduly engorged. Hence the necessity for caution in immersing the body in perfectly cold water. The ordinary sponge bath is sufficiently invigorating, and though requiring some care at first, is rarely productive of any but the best results. It braces the skin by thoroughly flushing all its vessels and so increasing the activity of its glands, while at the same time it imparts a healthy tone to the entire nervous system. The very effort necessary to withstand the first shock, be it not too violent, is productive of good. The colder the water, so long as warm reaction follows its application, the greater will be its tonic or stimulating effect. All cannot, indeed should not, adopt at once and without preparation the quite cold bath, any more than they could or should, without the necessary training, attempt an athletic feat requiring great strength and endurance. But just as the blacksmith's muscles gradually gain strength by use, so do the cutaneous nerves acquire power to resist external influences by the exertions they make to withstand the slight shock of each successive bath. Experience has shown that those who can take the cold or even tepid bath daily are less liable than others to "catch a cold;" or, speaking more correctly, to lose heat suddenly. Results at times follow the use of the cold bath which are clear indications that the luxury—for it is such—should not be again indulged in; as, for instance, when the skin remains blue and cold in spite of friction. Here reaction is wanting. Or, again, if for some time after the bath, the bather should feel languid and disinclined for work. In that case the reaction has been too much for his nervous system; and in either event tepid water should be substituted for cold in future.

Wet Towel or Sheet.—A *wet towel* wrung out and applied with vigorous friction forms a useful substitute for the sponge-bath for delicate people who shrink from the shock of immersion, and in most cases it will in time so strengthen and accustom the skin to variations of temperature, as to prepare it to endure the other and more tonic bath. Where the circulation is feeble, the towel may be dipped in water of 80° or 90° Fahr., lowered from day to day to cold, the towel being used wetter and wetter each time. By this means the power of reaction will be increased, and the susceptibility to chill and catarrh much diminished.

A *wet sheet* as a frictional method is a little more severe, the water being used quite cold, and the body being entirely uncovered. The sheet is thrown on like a long cloak, and rubbed loosely up and down for three or four minutes. For those with fairly good circulation, but uninured to cold water, it is the best means of accustoming them to it, withdrawing, as it does, but little animal heat, and occasioning but little physical exertion, yet affording at the same time a gentle though sufficient stimulation to the skin, and through it to the nerve centres. As with the towel, the wetter the sheet can be borne, so that reaction follows, the better, while the dryer it is used, the more rapid will be the reaction.

River and Sea Bath.—Under the head of "cold bath" we must not omit to notice river and sea bathing. This has many advantages over the sponge or even the more thorough domestic bath. After a good dive and sturdy swim, to quicken the circulation and assist in effecting a reaction, there is far less risk of taking cold. In the pure sea air also that is rapidly passed through the lungs in swimming, the amount of health-giving oxygen is very much greater than in the impoverished air of the best ventilated bath room. Here, as elsewhere, the earlier the bath the better. At all events if a swim is to be indulged in after breakfast, that meal should be a light one. The presence of an increased amount of blood in the stomach is one of the essentials in digestion; hence, everything that tends to divert it from that organ retards the process and is hurtful. Assuming a proper reaction to occur after bathing, the blood will forsake the stomach and flow towards the skin. The common results of disregarding this plain physiological law are indigestion, flatulent pain, and headache. For like reasons, all mental strain, reading or deep thinking, should be avoided for half an hour after a heavy meal, by which time the powerful juices of the stomach will have obtained a fair hold upon the food to be digested. These remarks apply more especially to out-door bathing, for the stimulating action of water is in proportion to its agitation. But there is a more immediate danger than that of reaction, which withdraws the blood from the stomach during digestion—the danger of congestion. If this was to be guarded against in the morning cold bath at home when fasting, it is clear that after a meal when, to aid digestion, the internal organs have already drawn towards them large supplies of blood, greater care is necessary when such a contingency is still more to be apprehended. Those with very pale skins, who are technically termed anæmic or bloodless, as well as those having any affection whatever of an internal organ, should never bathe in the sea, or indeed at home in cold water, except under medical advice. These remarks apply also to the aged and the very young—to the former on account of their diminished powers of resistance, and to the latter because of their tenderness. Some children bear without suffering the sudden chill of the cold bath, or the plunge in the sea; a few thoroughly enjoy it, but to the great majority it is little short of torture. It is really astounding that a loving and devoted mother should find it possible to look on so calmly and watch her tender little child enduring agonies unutterable at the hands of a repugnant female attired in orthodox blue raiment, as she remorselessly dips it again and again, to well nigh drowning, to the accompaniment of a time-worn tune and thread-bare words of endearment. This may be Spartan love, but surely it cannot be called English. Many a poor child so treated has grown up with a dread, nay, even a hatred, of the very sight of the sea, which was associated in its mind with so much early misery. It is notorious that a dog can never be trained to take to the water by violent immersion.

Timid children are the same, and must be gradually inured to cold water by means of tepid baths.

Among the luxurious, the ailments which are the result of indolent habits quickly yield to the genial influences of one or other of our watering-places; and while all the benefit is attributed to the change of air, or, perhaps, to the mineral water drunk, it is far more likely to be due to early rising, followed by a refreshing swim.

Hot Bath.—In a perfectly natural state, when man exposes his skin to the healthy influences of the air, and consumes only such food as is necessary to restore the waste occasioned by out-door invigorating exercise, it may not be so essential to the well-being of the skin that its pores should be assisted in their efforts to cleanse themselves. Cold river or sea water may suffice for the washing process, unaided by either heating the water, or the use of soap. The enervating habits of life in cities, however, make such accessories necessary; so that the daily bath, in cold or tepid water, has to be supplemented by more thorough ablution at least once in the week: better still, twice. Happily, the Saturday night bath is such a permanent institution in this country as to need no description here—at any rate, so far as concerns the plan on which it is performed at home. Many people, however, prefer to take the weekly, or bi-weekly, cleansing bath at the well-appointed public baths, now so numerous and accessible. In this method there is a slight element of danger. First, because, for convenience, the visit to these baths is often made too long a time before retiring to bed; and next, because there is risk of a chill on the way home afterwards, the hot water having opened the pores of the skin. Both these objections are surmountable; for although undoubtedly the very best time for such a bath is immediately before bedtime, and the place as near as may be to the bed itself, so that the process of gentle perspiration may be encouraged with impunity; yet such a prolongation of the sweating process is not imperative. The way to prevent mischief after a wash in hot water at the public baths is to finish with a cold, or nearly cold, shower-bath, arrangements for which will be found suspended over some three or four of the ordinary baths at these institutions. The effect of the cool shower is to brace the nerves, removing the lassitude often experienced after the warm bath; and, by closing the pores, preventing any bad result from ordinary exposure in getting home. Those who have the accommodation for taking a warm bath at home will find a double handful of common salt thrown into the water after the cleaning process has been performed, a very beneficial addition. The saline particles are very penetrating, and no amount of rubbing will remove them from the skin, upon which they exert a most useful, though a very gentle, stimulating influence, especially salutary in cases of sluggish liver. Not only does this act locally on the skin, increasing its secretions, but also quickens the processes of nutrition in all the tissues of the body. Warm sea-water baths are recommended for this, among many other reasons.

The effects of hot and cold baths may be said to be about the same, so far as the skin is concerned, although they are arrived at by different routes. Each method tends to increased circulation, but the choice of bath requires to be regulated by constitutional considerations. In health, the morning bath should be as cool as can be comfortably borne (always assuming that a proper reaction can be relied upon to succeed it), and the warm bath should be used as a periodical cleanser. In disease, or in a delicate condition bordering upon disease, the case is altered. Speaking generally, and without defining any particular degrees of heat and cold, the warm bath increases the heat of the body, while the cold bath lessens it. But owing to the system of compensation (which we have before explained to be effected by means of perspiration and evaporation, tending to equalise the temperature throughout the body), the rise or fall in the normal heat of the skin occasioned by the hot and cold water takes place within the limits of a few degrees—viz., from 1°·8 to 3°·6 Fahr. As a sensation, cold, however, is less agreeable than that of warmth, and produces greater congestion in the brain and lungs; for although increased warmth of the skin causes distention of these organs, it at the same time relieves them by drawing off the blood to the surface. Again, the effect of cold is to deepen respiration, and to retard the contractions of the heart; the air breathed is denser, and so richer in oxygen, and thus internal heat is created to balance the loss taking place at the surface; whereas the warm bath, while it causes less air, and therefore oxygen, to be taken into the lungs, produces increased heat of the body by the mechanical heating of the blood at the surface. Hence, the cold bath warms by *stimulating* the functions; the warm bath by *assisting* them. The feeble muscles of an indolent but otherwise healthy man derive strength from the cold bath, and he is thus encouraged to take more exercise and becomes better nourished, whereas muscles over-fatigued by violent effort experience relief from a warm bath. The one case needs urging, the other helping. Where there is no reserve force to draw upon, a cold or even cool bath is injurious. Owing to the disposition of clothing about the body, its temperature is in a constant condition of change and readjustment, and a man worn with excessive muscular labour is very susceptible to these differences, and the soothing influence of the warm bath to such a person is mainly due to the elevated and equable heat diffused throughout the body. Here, as in sleep, the calming effect is the result of the usual strain being taken off most of the functions of life. Invalids may be divided into two classes—those who have a reserve of strength, and those on whose resources a demand should not be made. The former thrive on cold baths, the latter on warm.

A *warm bath* may be said to range from blood-heat 98° Fahr. to 101° Fahr., and the effect is little more than by warming the blood to slightly quicken the heart's action, and distend the vessels of the skin. If the respirations become, even in such a bath, frequent or deep, and the perspiration profuse, as is the case with some persons, the bath must for them be considered very warm. Many experience these effects in a bath of but 102° Fahr., while others do not obtain like results under less than 114° Fahr. Anything hotter than this should be used with great caution, and for not more than a few minutes at most. It is a powerful stimulant to the skin, and through it, by reflex action, on the heart and blood-vessels. In a general way, the stimulating effect of a warm bath is in proportion to the increase of heat, and the quieting effect to the decrease. Many people have found a warm bath enable them to dispense with sleep. Napoleon, after the fatigue of a battle, had recourse to it instead of yielding to sleep, and so was sufficiently refreshed not only to push on in the night, but to engage the enemy on the succeeding day. The explanation is simple. The weariness of the muscles is occasioned by the accumulation of the waste produced by their functions, and the body being overtired and so unable to supply further secretions, the heating of the blood facilitates the process of renovation, and so, for the time being, effects the same result as is ordinarily brought about by physical repose. Such, indeed, is the restorative influence of the warm water to the jaded frame, that a weary reveller returning home from a ball, and having perhaps but four hours to rest before resuming work, would find that half-an-hour in a warm bath would make the little time left for sleep, equal in effect to his usual night's rest.

We have spoken, however, of the hot bath as a cleansing process also. In this capacity it has to call to its aid an article of ordinary domestic use, the nature of which is comparatively little known. This article is soap. Let us consider for a brief space of what this great cleanser consists, and when we have done this, we shall have added to our knowledge of the effect of heat, and of water, a third great agent in cleansing the skin, and shall be prepared to understand the bath of baths which is a combination of all three. But first of all, what is soap?

SOAP.

The hard soaps employed for domestic purposes are generally made by boiling together certain animal or vegetable fats or oils, and caustic soda, which is mostly obtained from the crude carbonate of soda of the alkali works by depriving it of its carbonic acid. When boiled with water and slaked lime, the carbonate of soda, technically known as "soda-ash," parts with its carbonic acid to the lime, the compound falling as insoluble carbonate of lime, whilst the caustic soda remains dissolved in the clear liquid. This liquid, which constitutes what is termed the ley or lye, is carefully drawn or syphoned off from the deposited carbonate of lime, and concentrated by boiling, until it is of the desired strength. The purity of the water used in preparing the ley, as well as in other parts of the process, is of great importance. Rain, river, and lake water, when accessible, are always preferred by the soap-maker to spring water, in which the presence of the salts of lime and magnesia decompose and consequently waste the soap.

The method usually followed in making hard soaps is to boil a weak solution of caustic soda ley with the fat or oil, stronger leys being added from time to time, and then a solution of salt and water. This causes a number of small granular particles to rise to the surface of the liquid. These which are entirely free from unctuous or oily properties are soap. By removing the spent ley, and boiling these particles either with a strong ley (or a weak one which concentrates as it boils), the soap separates in a granular mass, and after a few hours is transferred to large moulds or frames composed of masonry, iron, or wood, where it remains for three or four days, or until it has become hard enough to be cut up into bars or cakes, after which, if necessary, it is dried. The conversion of fat or oil into soap is termed saponification. The chief sources of the animal fats employed in making hard soaps, are oxen and sheep, the fat of both of which when freed from extraneous substances, and melted down, forms tallow; this, and certain vegetable oils, constitute the base of most hard soaps.

Cocoa-nut oil is used for the manufacture of marine soaps, because, unlike all other kinds, it is not rendered insoluble by brine, and therefore will produce lather when used with sea water. Hard soaps can be obtained by using potash instead of soda, provided the fat be a solid one. Such soaps, however, are of a softer consistency than those made from soda. Caustic potash is, therefore, generally confined to the preparation of soft-soaps, the best of which form the basis of shaving soaps. Owing to its caustic nature, soft-soap is unfitted for general use as a skin detergent or cleanser.

The following are the principal varieties of domestic soaps, the cruder kinds of which are often indiscriminately used for washing clothes and cleansing the skin. When employed for the latter purpose, however, they are frequently subjected to a different treatment, as described under toilet soaps.

Castile Soap—Marseilles Soap—Venetian Soap.—In the soap prepared at Marseilles, a larger proportion of olive oil is used than in the other varieties. The olive oil is invariably mixed with other oils, such as linseed, poppy, or ground nut. By this addition the product is rendered less hard, and more readily miscible with water. The veined appearance is produced by pouring into the soap when in the pasty condition from the rose of a watering-pot soda-ley containing a small quantity of sulphide of sodium. White castile soap is a superior variety, and owes its excellence to the purity of the substances from which it is made. It is in high repute as a safe and emollient skin-soap.

Castor Oil Soap.—Made from castor oil and soda. A very emollient soap.

Cocoa-nut Oil Soap.—Cocoa-nut oil is obtained by boiling the crushed kernels of the fruit of the cocoa-nut palm. Soaps made with this oil have a capacity for absorbing about three times as much water as ordinary soap, and lather freely.

Lard Soap.—Lard and soda afford a very white and pure soap, entirely free from smell.

Palm-Oil Soap.—This is made from the oil yielded by boiling the fruit of the Guinea palm. Few soaps rival in excellence and emollient properties that made by saponifying palm oil, whether bleached or unbleached, with soda. Palm-oil is a very general ingredient in toilet soaps.

Resin Soap, Yellow Soap.—Resin and soda when boiled together are incapable of forming a normal soap, since the resin dissolves in the alkali, and the product never becomes hard; but by the addition of tallow, in much larger proportion than the resin, an easily soluble, useful, and cleansing hard soap is obtained, which lathers freely. If the resin be in undue excess, the soap will have an irritating effect when applied to the skin, and as it will in these circumstances be wanting in firmness, this characteristic will indicate its inferior quality. The lighter and brighter coloured varieties of this soap, are manufactured from a very fine light-coloured resin imported from America.

Spermaceti Soap.—Made from spermaceti and soda. A very emollient soap, but rarely made.

Silicated Soap.—In making many of the inferior kinds of soap, for a great part of the tallow, palm oil, or other fatty component, a solution of silicate of soda is substituted, which is much cheaper, and gives an equally hard and cleansing soap.

Tallow Soap, Curd Soap.—The purest curd soap is made from tallow and soda only. An excellent soap if well made.

Toilet Soaps.—These may be any of the before-mentioned soaps, re-melted, coloured, and scented. The most usual basis is pure white curd, or more frequently, bleached palm-oil soap. Sometimes they are made by cutting scentless soap into shreds, adding perfume, and then re-uniting the shreds into a mass by means of pressure. Many of the English toilet soaps are special preparations, obtained from the same materials, but more highly purified than those used in the preparation of the ordinary hard soaps. The colouring matter and perfume are added to the soap when it is in the frame, and, therefore, after its removal from the pan, the heat of which would volatilise the fragrant essential oils. The addition of a small quantity of beeswax is sometimes made to toilet soaps, with the object of making them firmer and of improving their appearance. *White Windsor Soap* is sometimes made from curd soap re-melted, and at other times from olive oil, tallow, and soda, both varieties being scented with volatile oils. *Brown Windsor* is the white coloured with caramel, burnt sugar, or umber. Formerly the white became darker by age; hence its greater value. Large quantities of brown windsor soap are now made from palm oil soap. *Glycerine Soap* is any ordinary toilet soap containing about $\frac{1}{20}$th its weight of glycerine. *Honey Soap* consists of the clearest specimens of resin or yellow soap, coloured with saffron, and scented. Honey was originally used to give the colour. The best kinds of honey soap are derived from a mixture of palm oil, or olive oil, and curd soap, coloured and scented. *Transparent Soap* was formerly, and is now occasionally, made by dissolving dry tallow soap, or tallow and yellow soap in spirits of wine. The clear solution when cool is run into moulds, in which it is kept until of the required hardness. Large quantities of transparent soap are now obtained by boiling together cocoa-nut oil, castor oil, tallow, sugar, and soda ley. *Almond Soap*—the best is made from lard, suet, and cocoa-nut oil, and scented with oil of bitter almonds. The cheaper and inferior kinds are perfumed with an artificial oil of bitter almonds, made from benzol and nitric acid, and called "essence of mirbane."

The various colours of the different fancy and toilet soaps are derived from the following sources:—*Red* from vermilion, chrome red, coralline, dragon's blood, and carmine. *Brown* from caramel and umber. *Yellow* from palm oil, annatto, and saffron. *Blue* from Prussian blue, ultramarine, litmus, and indigo. *Violet* from fuchsin dissolved in glycerine. *Green* from a mixture of palm oil and ultramarine. Although many of the above materials are entirely harmless, there are others which in this respect are at least questionable. Such are vermilion, a mercurial compound; chrome red, a preparation of lead; and fuchsin, one of the coal-tar colours, which very frequently contains arsenic.

Medicated Soaps.—These are the ordinary hard or toilet soaps with which some medicinal agent has been incorporated.

That so important a commercial product as soap should be occasionally adulterated will cause little surprise. The chief materials used are dextrine or

British gum, starch, gelatine, pumice stone, baryta, and other insoluble earthy matters. Fortunately, with the exception of the first of these, none dissolve either in hot or cold water, and therefore settle at the bottom of the basin upon standing, and so their presence may be readily detected.

Individually, the two substances employed in the manufacture of domestic soap are singularly ill-adapted for the purpose of cleansing the skin. Caustic soda being powerfully corrosive, dissolves the cuticle when applied to it; whilst the oils and fats, from their well-known inability to mix with water, are altogether unsuited for ablution. But when the two, by being boiled or heated together, are made to act chemically on each other, the distinctive qualities of each are obliterated and a new compound is formed, which is not only entirely harmless to most skins, but readily soluble in hot water and miscible in cold. In short, this substance, which is soap, possesses so specific a value as a cutaneous cleanser that, after a lapse of nearly two thousand years, the inventive mind of man has failed to supersede it, or even to devise an equally efficient substitute.

The rationale of the cleansing action of soap is as follows: the dirt adhering to the body is mostly composed of dust and other extraneous matter combined with the perspiration and the greasy excretion from the skin. When ordinary hard soap is brought into contact with water it is decomposed and gives up part of its soda, which unites with, and removes from the skin, the unctuous dirt thus rendered miscible in the water used for washing. As the more the liberated soda is diluted the less will be its caustic effect on the skin, it is clear that a liberal supply of water should accompany the use of soap in personal ablution.

The Turkish Bath.

Within the last twenty-five years, another kind of bath has become naturalised in this country, which in its salutary influences on the skin is perhaps unrivalled. It is not a little curious that this bath should be precisely similar in principle to that established ages ago in Britain for the comfort of conquering Roman legions. Fifteen hundred years have passed since these noble baths, the remains of which are still preserved in many parts of England, flourished under the Roman invader, and were for that all-sufficient reason shunned, as a matter of course, by our half conquered and still haughty ancestors. Not so with the Turks, who, after they had captured Constantinople, rapidly adopted the Roman baths, or Thermæ, the principles of which the Romans before them had imported from the country of the conquered Greeks. And so it has come about that this bath, which we refused to inherit long ago from the Romans, has at last, with certain modifications, been accepted by us at second hand under the title or misnomer of "Turkish bath." Perhaps a few words will not be wasted in endeavouring to trace its early history. Hamâm, an Oriental name for the Turkish bath, is literally hot spring; and Captain Kennedy, in his travels in Algeria and Tunis, states that such springs are commonly met with in the East. He mentions one, the Hamâm Meskhoutin, having a temperature of 203° Fahr. The vapour produced by the heated rocks around similar spots, in all probability suggested the artificial form of vapour bath long held in repute among the

American Indians. The sweating houses which were common in parts of Ireland down to the commencement of the present century were similar in construction. A little pyramid was built of stones, a hole being left at top, and another at the side where persons could enter, and seat themselves on a bench of stones within, after the place had been sufficiently heated by burning peat. To prevent the escape of heat, the two apertures were temporarily closed with sods. The bather entered naked, and when duly sweated, returned home and to bed. These, however, were at best but clumsy methods for procuring increased perspiration. For the most perfect apparatus for this purpose we are indebted to the Greeks, who taught the Romans to construct fires under the floor of the bath, whereby a hot dry-air bath was produced. This under-fire, which is the principle upon which our Turkish bath is heated, was the Roman method for heating their houses, as well as their baths or thermæ.

The different parts of the bath proper were: *Vestiarium*, the undressing and dressing rooms; *Tepidarium*, the moderately warm room; *Calidarium*, the warm room; and *Laconicum*, the hottest of all, but rarely used. Having passed through these, the Roman bather entered the *Frigidarium*, where he was soused with cold water, and remained to dry. Owing to the extreme heat of the Roman Thermæ, and the excess to which indulgence of the luxury was practised, an edict was issued limiting the duration of the bath to two hours.

The Turkish bath in Constantinople consists of three parts: an outer hall, a middle, and an inner chamber. The first is open to the sky. In the centre is a fountain surrounded with plants, and a platform running round the hall is parted off into stalls, each fitted with a couch. Here the bather strips, and binds a towel round his waist and another round his head, casting a third over his shoulders. Thence, with his feet protected by a pair of wooden pattens, he is led into the middle chamber. In this marble chamber, corresponding to the Roman *Tepidarium*, he reclines on a raised marble slab, chatting, smoking, and sipping coffee, until the warm air, in which floats a thin vapour, has brought out a profuse perspiration. From here he now passes on to what would be the *Calidarium* of the Roman bath, where the temperature is higher and the vapour greater by reason of water being constantly cast on the pavement. Lying on a slab, he is here, after a time, shampooed—*i.e.*, pressed, pinched, and his limbs bent and joints stretched till they crack. This done, an attendant scrubs him down with a camel's hair glove and a little water, rolling off and removing from the skin the loosened epidermis. Then comes the soaping, which is done with a wisp of palm, whereupon, the body being thoroughly cleansed, the operation is completed by a sousing from head to foot with warm water. From here he now departs robed in towels for the hall where he left his clothes, and there, lying once more at his ease, he is cooled with a fan of feathers by a boy. The whole process lasts about three or four hours, and is usually resorted to once a week. In many respects this is an improvement upon the Roman bath, which was often stiflingly hot. This excess, doubtless, was mainly its downfall, just as moderation explains the continued survival of the Turkish method. In other respects, however, it compares less favourably with the older bath, or, at all events, the pioneers who reintroduced this system of bathing into this country appear to have thought so, since we find the Turkish vapour, and the cooling process of fanning, replaced by the Roman plan of dry air, douche or plunge.

The first so-called Turkish bath naturalised amongst us was built by Mr. Urquhart at Blarney, in Ireland, about 1856, and this was followed in England by Mr. Crawshay's bath in 1857. Since then Turkish baths have multiplied considerably throughout the metropolis. Indeed, after the short outline just given of the Constantinople bath, and the pretty general knowledge all have more or less now-a-days on such subjects, it seems almost superfluous to describe the Anglo-Turkish, except as enabling one to make a few helpful suggestions on the subject. The chief object of this kind of bath is to warm, relax, and induce gentle and prolonged perspiration, and, although very high temperatures can be borne in dry air, 120° to 140° Fahr. is, in ordinary cases, sufficient. A temperature of 150° dries the skin, draws off the fluid from the blood, and, hardening instead of softening the scarf skin, interferes with its removal. Furnace men constantly work laboriously in a temperature of 200° Fahr., each man drinking as much as a gallon of fluid every hour to replace the loss by perspiration. When Turkish baths were novelties and experiments, a bather would often take in with him an egg, for the pleasure of seeing it cook on his lap as he sat in the hottest room. If we turn for a moment to what we ascertained when considering the skin as a regulator of heat, we shall find the explanation there of the different effects of heat on living and dead organic matter. And now for a word or two on the Turkish bath as commonly conducted in this country. So far as the essentials of this form of bath are concerned, the plan at all places is the same, the only difference being that some have hot chambers representing three degrees of heat, whilst others have but two. The first step is to throw off the shoes in the vestibule, an Oriental rule imperative as the laws of the Medes and Persians. In socked feet one then enters the *Frigidarium*, or cool room, which is either partitioned off into stall-like recesses, or, better still, into separate closets. Stripping here, one binds a cloth round the loins, and, provided with another to lie on, passes through a well-padded door into the *Calidarium*, the temperature of which ordinarily ranges between 130° and 140° Fahr. Here, for the next hour, or best part of it, the bather reclines either upon a marble slab or upon a zig-zag wooden chair, a most luxurious form of support for every part of the body. At this point personal idiocyncrasies have to be considered. There may be one or more chambers beyond of increasing temperature. Nearly always there is one of 180°, or thereabouts, and often another of over 200°. Some are heated to 240°, and even much higher. It is impossible to lay down any fixed rule as to when these extreme temperatures should be tried. Many habitual bathers make their way direct to one of the hotter chambers, and after ten minutes or so, return and spend the rest of the time in the *Calidarium*. Most beginners will, however, do well to content themselves with remaining their half or three-quarters of an hour in the *Calidarium*, or until free perspiration has been obtained, which will be greatly facilitated by copious draughts of water. The proper condition will be evidenced by the bedewed appearance of the entire body, and when this occurs the right moment has arrived for the next process—the shampoo. To attempt to increase this state of perspiration by even momentarily entering the hotter chamber would be a serious mistake. If visited at all, it should be before and not after reaching this stage. The only effect of a greater heat would be to dry the skin, which might refuse again to perspire, and so render the entire bath abortive. It is better to be contented with a moderate perspiration and to resign oneself to the shampooer, and at the next bath the pores will act more freely; or, if not, one might on the next occasion try the *Laconicum* first. Where there is great difficulty in producing full perspiration, some find it much expedited by a warm, and then a cold, douche before entering the *Calidarium*. This, however, is the exception. The process of shampooing is performed in the *Lavatarium*, and the plan is on the model of that already described as practised in Constantinople, as also is the course of soaping that follows. Here, however, the resemblance ceases, for before returning to the dressing room, where the Turk would be cooled by fanning, the Englishman, who is clearly more an antique Roman than a Turk, receives from the shampooer a warm followed by a cold douche; or, better still, releasing himself from further attention, plunges boldly into a capacious bath of quite cold water, and issuing thence is arrayed in the warm bathing-dress and towel-turban. He now returns to the *Frigidarium*, where, reclining on a sofa or in an easy chair, and soothed with a cigarette and a cup of Turkish coffee, he dreams away an hour more in a little world that knows neither pain nor care. At the end of this time, all moisture having disappeared from the surface of his skin, his wandering thoughts must be recalled to earth and his body to his clothes; and, returning once more to the outer world, he will feel, despite all loss by perspiration, just double the man he was. Such, in brief, is that matchless purifier, restorative, and luxury—the Anglo-Turkish bath.

With some the warmth of the bath will be found to increase perhaps over-much the action of the heart. When this is the case, or any oppression is felt in the head, a moment or two in the *Lavatorium*, or at the most a basin of tepid water thrown over the head, will suffice to remove the inconvenience. There are three grand maxims that all who use Turkish baths should rigidly observe. First, never to return to the *Frigidarium* until after the douche or plunge; secondly, to avoid all undue excitement; and thirdly, to retain as far as possible the horizontal position. Conversation should be sparingly indulged in at every stage of the bath, even in the final one; but it is especially to be deprecated in the hot chambers, where, if carried on at all, it should be in an undertone and quite desultorily. Physical exercise of any kind is objectionable, and no disturbing influence whatever should be permitted to interrupt the calm and even tenour of the bathing process. Occasionally the air of the cold room will strike a novice incapable of rapid reaction after the douche or plunge, as rather chilly, but this is a good quality, as the bather will find on further acquaintance; for the present he will do wisely to assist the skin by returning for say thirty seconds to the *Calidarium*. Copious draughts of water taken in the hot rooms are useful helps to perspiration, but excessive water drinking at times produces an ugly rash over the entire body. The shampooers seem singularly exempt from small ailments, the solitary exception being a little eczema on the feet from constantly standing in water.

There are people who seem to be unable to perspire at all in dry air; for them the only serviceable Turkish bath will be one possessing a vapour chamber. The temperature of such a chamber usually varies between 122° and 158° Fahr.; a heat at which vapour would be scalding, did not some of it, falling on the cooler skin, condense and thus mitigate the extreme heat. Finally, the objects of the Turkish bath may be summed up thus:—To preserve health and to cure disease. With the last it is not our province here to deal; with the way in which it preserves health and so prevents disease we are in a measure familiar. In an artificial state of life, encumbered with clothes that exclude the air, enervated with various excesses, late hours and unwholesome food, the skin can scarcely be kept in a healthy condition by the use of ordinary ablution. By such means the outside may be cleansed, and in a natural state, exercise and the effect of bracing air on the skin would do the rest; but circumstanced as men are in cities, we require something that will help the skin to act, and this is the sole object, the Alpha and the Omega of the Turkish bath.

Conditions that Influence the Health of the Skin.

Cleanliness.—It is not flattering to man's character for cleanliness that his natural covering should compare as unfavourably as it does with his linen—that he should be content with a clean vest less often than a clean shirt, and with a clean skin less often than either. If health were preferred to appearance, the order of comparison would be shirt clean, vest cleaner, and skin cleanest. One is reminded of the remark applied to certain peasantry who were for ever washing a clean shirt and wearing a dirty one, "they keep one to wash, and the other to wear." It is much the same with the shirt and the skin. Not from any lack of cleanly principle, but simply for want of a standard of cleanliness as definite in the one as in the other, and as good a knowledge of the skin as of its artificial coverings. The profuse perspiration consequent on hard work will cleanse the skin, if aided only by an occasional sluice; but, in Nature's eyes, the sedentary man that is content with such ablution merely, habitually wears a dirty skin, and sooner or later will suffer discomfort accordingly.

Sufficient has been said on the use of baths, and of the nature and value of soap; but perhaps a word on the special management of the face would not be out of place here. As a rule, it is well to make a lather with plenty of soap and warm water, which should then be rubbed into the skin, not with the towel, flannel, or glove, but with the hands. The soap should then be completely washed off with tepid water, and finally the face should be bathed with cold water. Those who find soap irritating to the skin would experience relief by using a teaspoonful of sal volatile, or a few drops of spirits of ammonia, in a quart or more of distilled water. It cleanses the skin completely without causing irritation. It is perhaps desirable to mention here that the small black specks on the face, to which young people from fourteen to eighteen years of age are particularly subject, and which are caused by obstruction of the oil glands, are easily removed by pressing with the thumb nails, and so emptying the glands. When this has been done, the frequent use of soap, hot water, and friction will prevent the recurrence of them to a great extent.

Alterations of Temperature.—In the course of our review of the Turkish bath, we have seen that man is capable of enduring extreme heat, far greater indeed than that of a tropical sun. His powers of supporting intense cold are also sufficiently attested by the exploits of the Arctic explorers. Yet if the vitality be low, and the person be subject to skin affection of any kind, sudden transition from heat to cold, or the reverse, would probably overtax his powers of resistance, though the variations of temperature were comparatively slight. On the other hand, if opportunity be given for the skin gradually to acclimatise itself, even delicate people may be brought to bear the change without much inconvenience. It will be said that the beneficial effects of the cold douche, after the extreme heat of the Turkish bath, seem to refute this argument. The different result obtained from the bath, however, is due to the variation of temperature being merely external, and to the fact that the reaction following it promotes nutrition. When, as in the case of a chill, no reaction occurs, the mischief resulting is due to the internal effects, whereby the process of nutrition is disturbed, and the evil will last until that has been restored. To susceptible skins even the ordinary heat of an English summer will occasion profuse perspiration, which if not constantly removed by ablution will decompose, and give rise to local inflammation. There are those, too, who on the first approach of winter suffer in hands and feet from that irritating condition popularly termed chilblains, resulting from the circulation being too feeble to overcome the resistance offered to the passage of the blood by the contracting of the vessels by the cold. The only way to make the circulation effective is to dress warmly and to improve the general health; as the strength increases these troubles will cease.

Light.—The influence of sunlight upon the appearance of the skin can hardly be overrated. Recent experiments with the electric light, which of all artificial means of illumination most nearly resembles sunlight, have shown how important a part light plays in promoting growth. It has long been known that plants entirely deprived of light quickly droop. But a short time ago the beneficent action of light was forcibly illustrated. At the close of a public lecture it was found that some buds which had remained on the lecture table had actually blown under the influence of the electric light, while others, which had been purposely kept in the dark, had made no progress whatever. Animals, too, are well known to have similar susceptibilities, and it is certain that much of the pallor observable in the faces of those whose lives are passed in our gloomy courts and alleys and underground workshops is due to insufficiency of light. No wonder, then, that children reared in badly-lighted nurseries and æsthetic people, who delight in small windows with coloured glass still further to dim the entering light, should pay the inevitable penalty in pale faces and impaired health.

Certain skins are very susceptible to the direct action of the sun's rays. Freckles, or small spots of discoloration, are due entirely to an exceptional formation of pigment in the favouring light of the sun, and sometimes fade as rapidly as they come. The heat rays of the sun act in just the same manner as a fire or a mustard plaister, causing general pigmentation, or sunburn. Absence of light is said to stimulate the cells in which pigment exists, causing them to contract and so hide the pigment; hence the surface becomes lighter in colour, returning to a darker tint again on the re-application of light.

Exercise by bringing into increased action all the organs of the body, stimulates all the functions of the skin. But to be perfectly efficient, exercise must be agreeable, and to be agreeable it must be complete—that is to say, the mind, as well as every other organ, must enter into the occupation. An aimless, friendless, dreary, or monotonous walk is a half-hearted occupation. Exercise to be healthful should be regular, moderate, suited to sex and age, and should be rendered as enjoyable as possible. Walking, riding, rowing, lawn tennis, skating, etc., suit the adult; the gentle jolting motion of the carriage those of more advanced years. It should be borne in mind that, beneficial as the breeze is, the body profits still more by using its own efforts to pass rapidly through the air. Motion through still air is far better than rest in moving air. By the enjoyment of judicious exercise, as by the bath, tissue changes are more rapidly effected, digestion, nutrition, respiration, and action of the skin are promoted, the temperature of the body is maintained, and the mental powers invigorated.

Air—Food—Clothing.—Within the somewhat narrow limits of this section, it would be impossible to do more than slur over such wide questions as these. Food and clothing will be found to have been exhaustively dealt with in special articles; and as regards the necessity for free air, although it opens up a large question when viewed in some of its bearings, such as climate and occupation, and to this extent incapable of consideration here, it is in a general sense well understood and its importance recognised.

Irritants.—Some individuals suffer much inconvenience from what are apparently trivial causes, such as scratching and overwashing, or from wearing flannel or woollen material next to the skin. It is important that care should be taken by those subject to these local irritants to avoid as far as possible all risk of irritation, as tedious and distressing affections of the skin often result from neglect of this precaution. It would be well for those who are unable to tolerate the irritation of flannel to wear silk vests. Scratching the skin after undressing or after a warm bath is particularly to be avoided. It is often merely a habit.

Poisonous Dyes in Clothing.

There is reason to believe that cases of mischief arising from this cause are of less frequent occurrence now than they were a few years since. In the great majority of recorded instances the poisonous ingredient has been arsenic. Large quantities of this substance are used in the preparation of certain dyes, and unless, after it has effected its purpose, measures be adopted to entirely remove this poison, such colouring matter would be highly injurious, and quite unfit for dyeing articles of apparel. A pigment, known on the Continent as fuschine, and in England as magenta, solferino, rosaniline, and aniline red, has been the source of the greatest number of cases of poisoning of this kind. Some samples of this dye when submitted to analysis yielded 2·073 per cent. of arsenius acid, together with 7·593 per cent. of arsenic acid.*

Another pigment called coralline, described as "a preparation of phenic acid," and employed to produce a brilliant red dye, was a few years ago the cause of many cases of such poisoning. The noxious properties of this dye were probably due to the presence of arsenic. Green tarlatans are said to be at times coloured with arsenite of copper, a particularly noxious ingredient for such purpose, as the dust is apt to get rubbed off and inhaled by others as well as the wearer. A very undesirable quantity of arseniate of alumina is often found in the pigment known as cochineal red. When the poisonous dye is contained in any material worn next the skin, the part with which the dye is in contact becomes in the first place swollen, red, and painful. Presently an eruption shows itself, usually consisting of a number of small blisters; and these vesicles, as they are termed, in process of time merging into each other, lead to ulcers. Accompanying these local symptoms there will be headache, languor, nausea, and more or less fever. If the suspected cause be the real one, on removing the dyed material from contact with the skin, the symptoms should gradually pass off, followed by a period of convalescence more or less protracted in proportion to the severity and duration of the attack. There is scarcely any article worn next to the skin that has not at one time or other been made the vehicle for transmitting poison to the body. A case was reported in the *Medical Times* of 1869 of a copious eruption on the chest arising from wearing a red "chest protector;" and in another case a similar effect was produced by the aniline dye in a flannel vest. Several instances of such poisoning have resulted from arsenic in the bright red tints of flannel shirts. Socks and stockings of this colour, either alone, or stripes of it upon a white or differently-coloured ground, have also given rise to severe attacks of inflammation of the skin of the legs and feet. Even hats are not exempt from these charges. After wearing one but a couple of days, a person, mentioned in the *Medical Times,* found his forehead swell and become painful; he then experienced headache and general indisposition, and an eruption soon appeared similar to that already described. Inflammation of the skin has attended the wearing of such simple articles as black silk gloves; and, still more frequently, others lined with magenta-coloured wool. In a case quoted by Dr. Birch, a vesicular eruption was occasioned around the ankles by wearing shoes lined with yellow leather, but no mention is made of the nature of the poison the dye contained.

COSMETICS.

Cosmetics may be defined as substances which are intended for application to the skin with a view to improving its appearance. In whatever form they may be prepared—whether as washes, powders, or pastes—cosmetics perform their office in some one of the following ways:—By covering or concealing the offending pimple, eruption, or other cutaneous imperfection; as repellants, stimulating the absorbent vessels to remove the local mischief: or they may combine both these methods; whilst very frequently they are not used with the object of hiding any blemish at all, but merely to give an artificial colour to the complexion, or a fictitious whiteness to the neck, arms, or hands. Rouge, the various face and pearl powders, the so-called " blooms," belong to the last of these classes, while those cosmetics employed to remove superfluous hairs are termed depilatories.

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* *Medical Times and Gazette,* Vol. I., 1870, p. 617.

With the exception of the inhabitants of Sparta and Thebes, who despised perfumes, the Greeks held ointments in great reverence. We read that it was from the summit of the sacred mountain of Thessaly that the nymph Œnone, the perfumer of Olympus, brought the secret of cosmetics. Circe also devoted herself to searching for efficacious plants to preserve her remarkable charms. The tragic poet, Sophocles, represents Venus before her mirror perfuming her hair; and Minerva anointing her chaste body. Under Solon, 150 years earlier, so great had been the abuse of cosmetics, that they were made the subject of legislation; but the prohibitions of Solon were unavailing, and so too were the railleries of Socrates, who said that the slave and the philosopher, when perfumed, had the same smell. Aristotle describes how the Greeks anointed their heads before their banquets; and the humorous poet, Alexis, informs us that doves, each impregnated with different essences, hovered over the guests, raining down upon them perfumes from their moistened wings. Some years ago a list was published of the various perfumes that were used for anointing guests on such occasions. Every part of the body had its particular application: mint for the arms, palm oil for the cheeks and breast, a pomade of marjoram for the eyebrows and hair, ground ivy for the neck; while for emergencies there were quince and white violets for lethargy and dyspepsia, and extract of vine leaves for depression of the spirits. In Rome, as in Athens, the use of cosmetics was indulged in to great excess by men as well as women. " Go where one will," says the epigrammatic poet Martial, " one smells the shop of Cosmo " (the fashionable perfumer). " Knowest thou not," he adds, " that my dog could be embalmed as much as thou ? "

The Romans appear to have been dependent for their servants on France, which has ever been the home of such accessories as are accredited with the power to enchance personal charms, and thus the French became the most renowned perfumers of Rome. Historians assert that the cosmetics used by Diana of Poitiers preserved all her charms to old age, and long after her rivals had withdrawn from competition with her. Anne of Austria introduced the paste of almonds—the cream which served to whiten the hands and shoulders. Louis XIV. loved not scents, and France loyally detested whatever had not the approval of Louis XIV. In England, perfumes and cosmetics are mainly indebted for their early patronage to Elizabeth.

The following list comprises most of the substances employed in the preparation of the various cosmetics :—

Almonds.—Both bitter and sweet almonds are used, sometimes beaten into a paste, sometimes in the form of emulsion. The latter preparation contains suspended globules of almond oil, on the presence of which the emollient properties of the emulsion depend.

Alum possesses astringent and possibly when applied topically (that is, to some particular spot) stimulating properties.

Arsenic Orpiment, or the yellow sulphide of arsenic, is a very common ingredient in depilatories.

Benzoin.—The tincture of benzoin possesses slightly antiseptic or purifying properties.

Bismuth.—There is probably no cosmetic in greater demand than the trisnitrate of bismuth. Mixed with French chalk or talc it forms *blanc de perle*, or pearl white. Bismuth was at one time the favourite dusting powder of the dramatic profession. All face powders have the effect of greatly drying the skin, but bismuth more especially. It must be borne in mind, however, that nature, in her efforts to keep the skin moist, is not to be thwarted without making great resistance, and the more the drying process is carried on the more she stimulates the secreting glands to produce moisture to overcome such condition. In time the walls of the glands become thickened and lose their contractile powers, and after a while a stage is reached, when the mouths of these glands permanently gape, and produce that pitted appearance so often observable in those who have habitually used such preparations.

Borax possesses antiseptic and slightly stimulating qualities.

Carmine.—See Rouge.

Chalk.—Prepared chalk, or carbonate of lime, is used in face powders, and to whiten the neck, arms, and hands.

Elder-flower Water.—Credited with removing freckles.

French Chalk or *Steatite.*—A silicate of magnesia.

Talc is a variety of steatite. Both substances are used to impart a pearly or opalescent appearance to the skin.

Lead.—Carbonate of lead, known also as white lead. This very objectionable compound is now happily rarely if ever used as a cosmetic. The subacetate of lead, in a more or less diluted form, is still sometimes used.

Lime.—Quicklime is much used in depilatories.

Mercury.—The poisonous salt perchloride of mercury, or corrosive sublimate, is an occasional ingredient in face washes.

Pearl-ash, or crude carbonate of potash, sometimes enters into the composition of depilatories.

Rouge.—This well-known cosmetic, so frequent an ingredient in face washes and powders, is made from the red colouring principle of the safflower, a species of carthamus, grown in Egypt, Spain, and the Levant. It is extracted by treating the plant with carbonate of soda, and afterwards decomposing the carthamate of soda, as the product thus formed is called, with lemon juice or vinegar. The powder so obtained, when dried and mixed with French chalk or talc, forms the best kind of rouge. Another kind is prepared from a solution of carbonate of potash water and carmine, a beautiful scarlet colour obtained from the cochineal insect.

Sodium Sulphide.—Frequently used in depilatories.

Starch.—Starch powder, either plain or mixed with orris powder and perfumed with essential oils, in which condition it constitutes "violet powder," is one of the least injurious cosmetics. It is commonly used as a basis or diluent for many of these preparations, and sometimes as a vehicle for depilatories. Its sources are wheat, rice, maize, and potato.

Styrax.—An odoriferous natural liquid balsam, used chiefly on account of its agreeable odour.

Wig Paste.—In this connection it may be interesting to note that actors and actresses are no longer subjected to the baneful influences of lead and paint as in days gone bye. Wig paste, as it is termed, by reason of its having been originally used exclusively to hide the line the wig made on the forehead, is now employed to coat the entire face, and so preserve it from direct contact with either paint or powder. The wig paste is itself tinted to the various shades required, but it can be further coloured according to taste. It contains nothing more injurious than a little oxide of zinc in combination with some kind of grease, usually tallow. By the application of this paste an actor can model his nose to any shape required.

Zinc.—Both oxide and natural carbonate of zinc or calamine, the one a white and the other a salmon-coloured powder, are frequently employed in the preparation of cosmetics.

A chemical examination of some of the best known and most widely advertised nostrums for beautifying the skin was, with one exception, attended with the comparatively satisfactory result, that no poisonous or dangerous ingredient was detected in them. Thus, one of the oldest and most familiar of these preparations was composed of emulsion of sweet almonds, borax, curd-soap, and styrax, scented with rose. A second contained bitter almond emulsion and corrosive sublimate or perchoride of mercury. Another was compounded of bitter almonds and elder-flower water. And a fourth of oxide of zinc, precipitated sulphur, glycerine, and rose water, the colouring matter being carmine.

A popular face powder contained oxide of zinc, prepared chalk, and starch, coloured with carmine and scented with rose. Two applications for rejuvenating the eyebrows contained charcoal and some iron oxide, combined with a waxy and fatty basis. In one case only, that of a depilatory, was arsenic detected.

But whatever the artificial face wash or cosmetic may consist of, whether purchased ready-made, or prepared at home, no better instructions can be given for the next step to be taken than those recorded by Goldsmith in the "Vicar of Wakefield:"—"My daughters seemed busy, and I observed them for a good while cooking something over the fire. I at first supposed they were assisting their mother, but little Dick informed me in a whisper that they were making a wash for the face. Washes of all kinds I had a natural antipathy to, for I knew that, instead of mending the complexion, they spoiled it. I therefore approached my chair by slow degrees to the fire, and grasping the poker, as if it wanted mending, seemingly by accident overturned the whole composition, and it was too late to begin another."

HAIR IN HISTORY.

The hair of both Jewish and Grecian women engaged a principal share of their attention, and the Roman ladies seem to have been no less sedulous with respect to theirs. They generally wore it long, and dressed it in a variety of ways, ornamenting it with gold, silver, pearls, &c. Men, on the contrary, amongst the Greeks and Romans and the later Jews wore their hair short, as evidenced by their medals and statues. This, indeed, formed the chief noticeable distinction between the sexes. Among the Gauls both sexes esteemed it a great honour to possess long hair, and hence came the expression "Gallia comata." For this reason, when subdued by Julius Cæsar, they were compelled to cut off their hair in token of submission. It was viewing such mutilation in this spirit that led those who afterwards quitted the world for the cloisters to adopt the shaven head, indicating that they thus renounced all earthly adornments when making the vow of perpetual subjection to their spiritual superiors. Gregory of Tours affirms that in the royal family of France it was long the peculiar privilege of kings to wear the hair uncut and artfully dressed and curled, everybody else being required to be polled, or cut close round the head, in token of inferiority. To cut off the hair of a son of France under the first race of kings was to declare him excluded from the right of succession and reduced to the condition of a subject. In the progress of Christianity, the elegance of long hair being deemed inconsistent with the profession of persons bearing the cross, it was prohibited by numerous canons and injunctions, the clergy of the Eastern Churches discountenancing the practice by their own example. All such measures, however, proving ineffectual, a canon was promulgated in 1096 stating that such as wore long hair should be excommunicated while living, and remain unprayed for when dead.

The ancient Britons also took great pride in the length and beauty of their hair, and constant allusion is made to this feature in the poems of Ossian. A young warrior condemned to be beheaded most earnestly implored, as a last favour, that no slave might be permitted to touch his hair, which was remarkably luxuriant, and that it might not be stained with his blood. Another incident, derived from other times, naturally suggests itself in this connection. There are few lines in Shelley more true to nature than those where, in "The Cenci," he pictures Beatrice pausing to make her last brief toilet at the scaffold foot:—

"Here, mother, tie
My girdle for me, and bind up this hair
In any simple knot: Ay, that does well,
And yours, I see, is coming down. How often
Have we done this for one another! Now
We shall not do it any more."

Not contented with the natural colour of their hair, which was commonly fair or yellow, our ancestors were in the habit of using lime, vegetable ash, and tallow to render it still brighter. The Britons shaved the entire face with the exception of the upper lip, the hair of which they, as well as the Gauls, allowed to grow to a very inconvenient length. Coming to later times, we find that the Anglo-Saxons and Danes also attached much importance to the cultivation and dressing of the hair. Before marriage, young ladies wore it uncovered and untied, flowing in ringlets over their shoulders; but after the ceremony they cut it shorter, tied it up, and assumed a head-dress of the prevailing fashion. The greatest disgrace that could befall a woman in those days was to have her hair entirely cut off, that being the penalty for a wife's infidelity to her husband. The Danish officers, quartered on the English in the reigns of Edgar the Peaceable and Ethelred the Unready, and who were the heroes of those times, captivated the ladies by the extreme beauty of their hair. At this period we are told that the clergy, both secular and regular, were enjoined to cut their hair short and shave the crown to distinguish them from the laity, and were, by special canon, forbidden to allow the hair to grow long, or to conceal the tonsure.

But after a while the clergy, fretting under the disfigurement to which they alone were condemned, endeavoured to persuade the laity to renounce long hair. Anselm, Archbishop of Canterbury, was much commended for his zeal in pronouncing the most terrible sentence of excommunication upon these incorrigible delinquents. A Norman bishop acquired great honour by preaching before Henry I., in 1104, against long and curled hair. So greatly were the king and his courtiers affected that they consented to resign their flowing ringlets, of which they had been very vain; and the prelate, who seems to have been prepared for his success, drew a pair of shears from his sleeve, and performed the operation there and then with his own hand. Stringent as were these and such like efforts to effect a reformation in the prevailing vanity, they hopelessly failed in their object, the fashion, after very short abeyance, reviving and flourishing with increased vigour. At length, in 1129, a blow was struck, by a mere dream, which, for a time, accomplished better results than had followed much stronger measures. A certain knight, says a contemporary historian, dreamed that some person suffocated him with his curls. As soon as he awoke he cut his hair to a decent length, and related his experience. The report spread all over England, and almost all the knights hastened to reduce their hair to the proper standard. Even this reformation, however, the writer continues, lasted less than a year, and then "all who wished to appear fashionable returned to their former wickedness, and contended with the ladies in length of hair." This state of things may be said to have existed up to the period when the enormous flowing white wigs came to be in vogue, which at once gave dignity to all ranks, from the king to the philosopher. But, from the difficulty of obtaining white hair in sufficient quantities to supply the demand, the dealers were forced to resort to artificial means to render hair of every colour white. For this purpose it was spread on the grass to bleach like linen, and also soaked in a lixivious water; but although this process for a time rendered it silvery white, it eventually relapsed into the miserable colour of a dead walnut leaf. To remedy this evil, hair powder was introduced, and thus wigs of all colours were made of a uniform whiteness. The last of our kings to wear this kind of wig was George III. Innocent as this powder was, so long as it was made from pure starch, it soon came, with the increasing demand, to be extensively adulterated with mineral substances highly injurious to health: so much so, in fact, as to necessitate legislative restrictions. Hence we find makers prohibited by Statute 4, George II., under severe penalties, from admixing any powder of alabaster, chalk, gypsum, etc., with starch, which was the recognised material. Paris set the fashion, afterwards adopted in England, of greasing these wigs to enable them to retain much larger quantities of powder. But, during the reign of George II., these unhealthy encumbrances fell gradually into disuse, surviving only within the precincts of our courts of law. In its last fight for existence, the greased and powdered wig found its staunchest friend in the physician, who remained true to it up to the middle of the eighteenth century. In its place came the frizzled hair and powdered heads, dressed "à la mode de Paris," which became so fashionable in England among all ranks of people that in seasons of scarcity of bread-corn, the evil was held to be attributable to the great quantities of wheat manufactured into starch for hair powder. And hence, in 1795, Mr. Pitt was led to look to this article as a proper one for taxation. This step tended greatly to check its general use, and English ladies began to appear on public occasions with their hair in its natural state, a good example, which was speedily followed by the other sex.

The Structure of the Hair and Hair-sacs.

Hair, which is a modification of the epidermis, is an appendage of the skin, having its roots in follicles or little jug-shaped bags. This hair-sac, as it is called, has a bulbous body and a narrow neck, with a funnel-shaped mouth, out of which the hair itself grows. In the base of the sac there is a depression, similar to that at the bottom of a wine-bottle, and fitting into this hollow is a papilla, which we have already described. The elements composing the sac differ from those of the rest of the skin in arrangement only. The outer coat is formed by a continuation of the papillary layer of the true skin, which, being strong and dense, preserves the shape of the sac, while the lining is furnished by a continuation downwards of the epidermis. As a rule, the body of the sac is situated in the substance of the true skin, but when largely developed it occasionally extends into the fatty layer beneath. The neck is on a level with the papillary portion of the sac, and the mouth opens on the surface of the skin. Each sac is surrounded by a complete and beautiful network of blood-vessels, but there is a special arrangement of vessels to feed the papilla at its base. Here it is that the hair is formed, the elements for its growth being derived from the blood circulating in the papilla, at the summit of which two or more small arteries unite, and, branching into capillaries, finally quit the papilla as veins.

The hair itself consists of a *root,* which is situated in the sac, and at the lower extremity becomes enlarged, which enlargement is termed the *bulb.* The under surface of this bulb is cup-shaped, and fits on and adapts itself to the papilla. The part of the hair that projects from the skin is called the *shaft,* the termination of which is termed the *point.* The substance of the shaft is composed of long, narrow pointed cells of a horny character, some of which contain a remnant of a nucleus. The cells are held together by a cement substance, in which are to be found air bubbles and pigment granules. In very dark hairs pigment will be found in the cells themselves ; and greyness is said to be due either to the absence of loose pigment in the cement substance, or to excessive accumulation of air-bubbles. In the centre of the hair the cells have more of the character of those in the deeper epidermis—that is, they are smaller, and contain nuclei. The difference in colour observable in the outer and inner parts of the hair, when viewed in transverse section, has probably led to the erroneous idea that the hair is a tube. The chief nourishment of the hair throughout its length is furnished by the papilla, the cells composing which firmly embrace the root. It is the rending of this close union which produces the jagged appearance at the end of a hair forcibly extracted, or as one may properly say "pulled up by the roots." But to lubricate the hair, one or two sebaceous glands generally open into each sac, which thus forms a little reservoir for oil, the neck being the point of contact where the grease is imparted.

The nerve supply is scanty, and although nerve filaments have been found in the papilla and root-sheath, the hair is mainly dependent in this respect on the neighbouring system of nerves, which, as we have already seen elsewhere, terminates in the true skin.

It should be observed that the follicles do not stand perpendicularly in the skin, otherwise the hair on leaving the surface would remain erect; their position is an oblique one, and hence the hairs lie smoothly, especially if they be allowed to take their natural sweep round the crown, which is their centre of radiation.

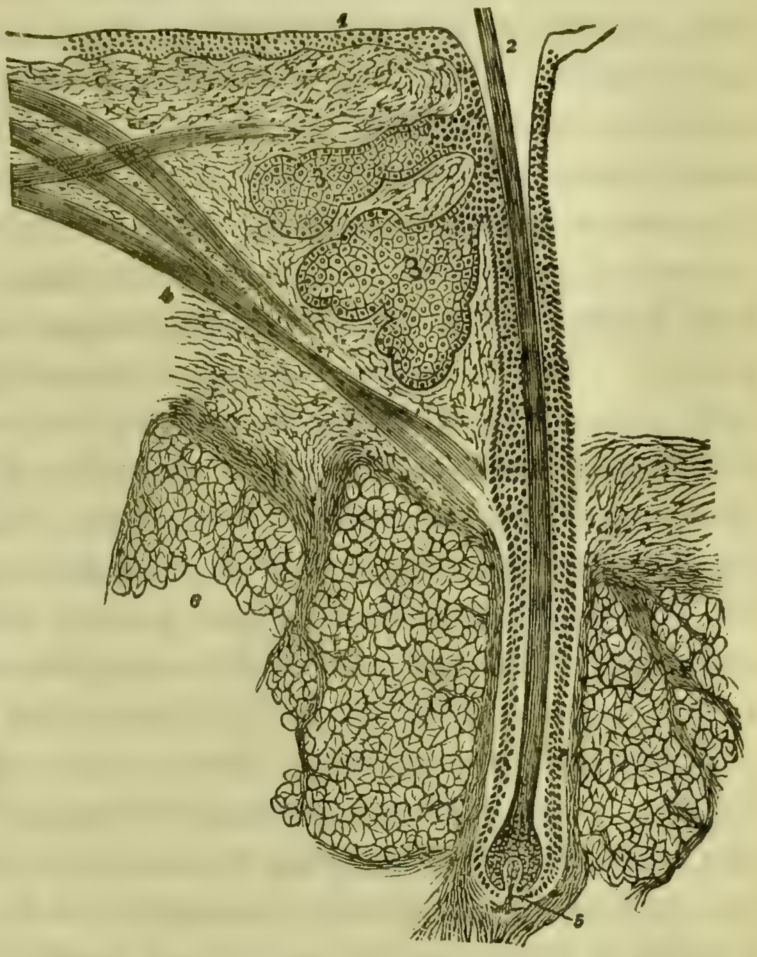

Fig. 4.—Longitudinal Section of Human Hair.
(*From Klein and Noble Smith's Atlas.*)
(1) Epidermis—only lower layer is shown; (2) mouth of hair sac; (3) sebaceous gland; (4) the muscle of the hair; (5) papilla; (6) fat.

The hairs in every part of the body are arranged in various geometric curves or currents. Those on the crown, as a rule, radiate from only one centre, passing downwards in graceful sweeps over the whole scalp. When, as is sometimes the case, there is a second crown or radiating centre, we find those unruly tufts that will not lie down. Proper discipline, however, will in time effect a reformation in this respect, the hair-bulbs that at first obstinately refused to turn in the required direction, yielding and adapting themselves to circumstances. The curves on the forehead radiate right and left from the median line downwards over the temples, forming the outer half of the eyebrows, and, in men, the upper portion of the whiskers in the region of the ears. The currents on the cheeks are downwards, curving round the jaw to the chin. The moustaches take two outward sweeps from the median line. Those centering in the armpit have currents sweeping forward over the chest to the median line, extending to just below the breast bone, whence by a double curve, having still the same centre, they cover the abdomen, and again descending the thighs, split and surround the knees. Another current, also starting from the armpit, sweeps round the back, branching off and encircling the shoulders, and descending the arms to the hands, where it curves in an outward direction. Besides these, there are combined currents in the front of the forearm, and an upward current on the back of the leg, that serve more completely to cover these limbs.

At the sides of the hair follicles, involuntary muscles are attached, whereby the hairs are drawn into an upright position, and the oil gland is assisted to discharge its contents. These are called the erector muscles, and to their action is due the condition before-mentioned, called goose-skin. We have said that the central cells mass themselves together, and so form the bulb. When this has been done, and as the process of renewal of the bulb continues, the upper cells are thrust on by the process of growth below, taking with them colouring matter formed in the root, and here, higher up in the follicle, they begin to form a pith and a part of the fibrous portion. The outer layer of these becoming hardened, and the cells pressed against each other at the sides of the follicle, soon overlap one another so closely as to form a cylinder, which is filled with the pith we have mentioned. The internal growth then takes place by means of the lower freshly-made cells pushing upwards those already formed to the top of the follicle, where, dispensing with its further support, the hair commences its external growth, and assumes the function of protector to the scalp. Thus, the hair-papilla being the seat of growth, it matters not that a hair be plucked out root and all, if the seed for a fresh root be still obtainable from the papilla; and as a matter of fact we know that the papilla has this power of reproduction. Among lower animals the periodical hair-shedding is effected by means of the fresh growth developing beneath the old. When a hair becomes too long for the papilla to be able to nourish it, a fresh root forms in the follicle, the gradual growth of which, in the end, ejects the older tenant. The tip of the hair is a perfect or typical point—that is to say, the finest needle is by comparison with it notched and wanting in symmetry.

The chemical elements entering into the composition of hair are carbon, hydrogen, nitrogen, oxygen, and sulphur; but different coloured hairs possess them in different proportions; while red hair yields in addition a reddish oil and a trace of iron. White hair contains, besides its proportion of these, sulphate of alumina, phosphate of magnesia, and at times—chiefly in the aged—a considerable quantity of phosphate of lime. The unpleasant odour arising from burning hair is due chiefly to the combustion of nitrogenous matter.

On the surface of the hair itself is the epidermal layer corresponding to the scarf skin. Here the scales, as they are pushed out of the follicle, overlap and take the form of the tiled or slated roofs of our houses, and so appreciably as to be recognisable by drawing the hair from point to root along the finger. If a hair is shuffled along between thumb and finger, the hair will always travel in the direction of least resistance—viz., from root to point. The innermost layer of cells in the hair-sac is arranged in the opposite direction, and so fits into those on the hair, and to some extent locks it in position. The elasticity of the hair, which is very considerable, renders it particularly susceptible to the influences of the weather, causing it to stretch in the wet and shrink in dry air. Hence it is that after being curled and shortened with the curling-iron, it loses its curl so soon as any exertion, such as dancing, by causing moisture on the skin, lengthens it. This peculiarity also has led to its being employed in certain kinds of aneroid barometers. As to the strength of the substance of the hair, its lifting power is marvellous. We are prepared to hear that, as in the case of Absalom, a head of hair will suspend the body of a man; but it has lately been computed that a single hair will bear a strain equivalent to a weight of 4 oz. If no more than a single hair grows out of each sac, the number of hairs on a square inch of the scalp varies from about 600 in the brunette to about 700 in the blonde, and as the superficial measurement of an average-sized head yields 120 square inches, this gives a total of about 80,000; but as many of the follicles emit two or more hairs, probably 120,000 would be nearer the mark. Among Europeans the shaft of the hair in section is usually more or less oval, especially when it curls naturally. The straight hairs approach nearer to a perfect circle.

Most parts of the body are covered with hair, the palms and soles being the chief exceptions. The properties and the sizes of the hairs differ, however, according to their position; fine and long on the head; short and stiff in the nostrils, edges of eyelids, and eyebrows; soft and downy on the general surface of the body. In length, the soft hairs measure $\frac{1}{12}$ to $\frac{1}{4}$ in., the stiffer kinds $\frac{1}{4}$ to $\frac{1}{2}$ in., while women's hair will range from 1 foot to 4, 5, or even 6 feet. Hair may be stretched from $\frac{1}{5}$ to $\frac{1}{3}$ of its length. It has also the property of generating electricity under the influence of friction, more especially in cold and dry weather. Hair grows at the rate of about 5 to 7 inches in a year. It is said to grow faster in summer than in winter. Of all that appertains to the body, the hair is perhaps the least perishable, even surviving the bones, which go to dust before any change takes place in the hair.

Hair fulfils many offices. It not only protects the head from heat and cold, but, being a bad conductor of heat, it assists in maintaining the temperature of the body. The eyelashes protect the eyes from dust, the moustache acts as a respirator, and the hair in the ear offers an effectual barrier to the inroads of insects.

The Management of the Hair.

The chief requirement of the hair is cleanliness, not necessarily daily ablution, for it is quite possible to wash the hair too much, but proper and thorough cleansing or shampooing for women once a fortnight, and for men once a week. The best agents for the purpose are good soap and hot water, yelk of egg, or Quillai bark. The last mentioned contains a neutral vegetable principle, scientifically known as saponin, found in certain plants, and bearing a great resemblance in its properties to soap. Saponin exists in the common soap-wort (*Saponaria officinalis*) in Senega root, and in several varieties of lichens, but it is found in greatest abundance in the inner bark of the *Quillaya saponaria* or *Quillai*, a small evergreen shrub, a native of Chili, by the women of which country it is largely used for washing the head, to the great improvement, it is said, of the hair. Formerly it was extensively employed, and it is we believe still, for removing grease from the finer kinds of wool and silk without injuring the colour, and for increasing their lustre. A small piece of the bark, stirred in cold or hot water, will be found to yield a copious lather. Dr. Beigel considers a solution of alcohol in water, or a solution of bicarbonate of soda, distilled water, and essence of vanilla, the best means of cleansing the scalp.

The use of oil or pomade requires a little discretion. All people do not need such aids, the natural secretions in some cases being sufficient. Those, however, who wet the head daily with cold water will find that, unless they replace the natural oil so removed, the mere dryness will lead to shedding of the hair.

Some persons require occasionally to grease the hair; they should, however, use but a small quantity of grease at a time. Nothing looks worse than greasy hair. The following formulæ have been selected from Dr. Beigel's work on Human Hair.

Oil.

Take Provence oil, 3 oz.
Essential oil of almonds, }
Oil of roses, } 2 drops of each.
Orange oil, 5 drops.
Lemon oil, 10 drops.

This may be easily coloured by digesting a little alkanet root in it for a few days.

Pomatum.

The simplest form of pomatum consists of about two parts of hog's lard and one part of beef suet, melted by a moderate temperature and scented with some essential oils. Without the scent it is termed plain pomade.

Take Plain pomade, 1 lb.,
Provence oil, 1 oz., mix and scent.

In "The Toilet in Ancient and Modern Times," by A. J. Cooley, the following receipt is given for preparing Macassar oil.

Take Oil of almonds (reddened) 1 pint.
Oil of rosemary, }
Oil of origanum, } of each 1 dram.
Oil of nutmeg, }
Oil of roses, } of each 15 drops.
Oil of Neroli, 6 drops.
Essence of musk, 3 or 4 drops.

Mix and add alcohol drop by drop, with agitation as long as it will bear it, or until two fluid ounces have been added.

But, on the whole, vaseline, chrisma, or adepsine, which are somewhat similar preparations, make the best base for pomades, as they do not turn rancid.

"Bandoline," used for rendering the hair glossy and keeping it in position is made thus:—Gum-tragacanth and distilled water are allowed to digest for five or six hours, then, having strained through muslin, press and add alcohol and rose water. Mucilage of quince seeds and Eau de Cologne are also used for a like purpose.

Both as facilitating cleanliness and as conducing to the strengthening of the hair it is desirable to keep it short. Some time back it would have been deemed absurd to apply this remark to any but children and men. But now that young women are commonly to be seen with quite short hair, it is just as well to admit that the ornament of luxuriant tresses is sometimes dearly purchased with physical suffering. Its weight, the tightness of its braiding, the painful pressure of the hair-pins, the fatigue involved in its arrangement, are a part, and only a small part, of the penalty for wearing long hair. Hair should be cut once a fortnight, long hair especially, otherwise the ends are liable to split. The ends only need be clipped or trimmed as it is called. Singeing is utterly valueless. Its supposed utility is based on the popular fallacy that the hair is a tube provided with blood-vessels, which when cut bleed. The hair shaft is solid, but owing to its cellular construction it is hydroscopic—that is, capable of absorbing moisture. A misconception of this fact may have led to the delusion. It may be well to mention here that the small knots at times found in the hairs of the beard are perfectly harmless, being caused by air penetrating the intercellular spaces and splitting the shaft. As regards brushing the hair, there is a tradition that "you cannot brush the scalp too much nor the hair too little." To say the least of it, this is very questionable. Some scalps will tolerate but little brushing, and even then the brush must be a soft one. Bristle brushes are preferable to wire ones, but constant scratching of the head by any kind of brush or comb is mischievous. "One is apt to forget," says Dr. Jamieson, in a lecture delivered in Edinburgh, "that the scurf re-forms faster than ever when thus roughly scratched away. Use, then, a soft brush, and use it gently." As to combs, the teeth should have blunt points, and should not be too close together, as they are apt to tear the hair; and on no account should a small tooth-comb be used. It is very important to frequently remove the sebaceous matter that forms on infants' and older children's heads, but this must be done by means of soap and water, and never by scraping with a comb. It is too much to expect that crimping and curling will ever be discontinued, simply because they are prejudicial to the hair; but that the constant use of hot irons, the strain of curl papers, and the crimping of the hair, twisted on pins to cause it to wave, must retard its growth and thin it, is obvious. At the same time such processes can only injure existing hair, and if used occasionally only and with discretion they need not be entirely forbidden. This remark by no means applies to the cruel practice of tightly winding up children's hair at night in papers in order to screw it into a curl by the morning. After what has been said on the nerves with which the skin abounds, a moment's reflection will suffice to show how ill-advised such measures of adornment really are. Sleep cannot be perfect rest, while the head is pressed on all sides by these sharp-cornered torturing pellets.

The reason hair curls when wound on a hot iron, is that the moisture on the side next the iron, being evaporated by the heat, the cells in that part approach one another more intimately, and this shrinking of one side only, forms a bend or wave. A piece of paper held to the fire will illustrate this effect of heat, by behaving in like manner. Again, the hair shaft not being equally strong in all directions, owing to its oval shape, it will bend on the weakest or flattened side, and this, apart from any question of moisture, is the cause of hair curling naturally. Almost anything, therefore, that will remove the natural oil and also dry the hair will cause it to curl—potash or ammonia, for instance; but as damp tends to destroy the curling, it is best to mix with it some aromatic oil, which will protect the hair when curling from imbibing any moisture to which it may be exposed. Professed curling liquids contain little else than an oil and some such alkali as potash. Curling, however, ceases to be a matter of concern after the hair has lost its natural hue and primitive freshness, and sooner or later this stage, with rare exceptions, awaits us all. Not that time alone blanches the hair; other insidious agents perform the same office as surely and far more expeditiously, while in some instances the absence of colouring matter is congenital. There are many recorded cases of hair turning suddenly grey through extreme terror or suffering. The evidence on which these cases are reported is not always satisfactory. Dr. Austin Flint, a distinguished American physiologist and physician, says:—"In examining the literature of this subject, it is difficult to find in the older works well authenticated cases of these sudden changes, and most of those that have been quoted are taken upon the loose authority of persons evidently not in the habit of making scientific observations. It is not necessary, therefore, to quote the instances of sudden blanching of the hair recorded by the ancient writers, nor those well-known cases of later date so often detailed in scientific works, such as that of Marie Antoinette or Sir Thomas More; and it seems proper to exclude also cases in which blanching of the hair has been observed only by friends and relatives, for in most of them the statements with regard to time are conflicting and unsatisfactory." An important case, however, was reported in a medical journal by Dr. Landois, in 1866, and quoted by Dr. Flint. In this case the blanching occurred in a single night, while the patient was under the daily observation of the physician. When examined microscopically, the white hairs were found to contain air globules, but there was no loss of pigment. It was in consequence of the presence of the air that the hairs appeared white.

Blanching of the hair may come about slowly under the influence of serious illness, during which, owing to imperfect nutrition, the secretions of pigment have become scanty or altogether ceased. In cases of severe neuralgia of the head, the hair has been often known to become grey in patches; the colour, however, usually revives as soon as the attack has passed off. Several instances are on record of this strange occurrence making its appearance on the first signs of the neuralgia, and departing gradually on the cessation of the pain. Dr. Pincus, of Berlin, in treating of pains in the head, mentions the occurrence of what he terms "diseased sensations" in the scalp. In some affections of the skin of the scalp, the corium becomes contracted and the fine nerve fibres in its substance are pressed upon. The sensations resulting Dr. Pincus calls "hair-ache"—a very apt expression describing a pain that upon the slightest touch of comb or brush seems to be instantly engendered at the root of each particular hair. In another phase of the same complaint, pressure, strain, or heat are experienced in the direction of the crown of the head. This often lasts for years, gradually culminating in a constant feeling of mental depression.

So far as health is concerned, nothing could be better for females subject to headache than the present fashion of wearing the hair short. Even the style of frizzing it over the forehead has advantages of a negative kind, for in that case, as also in the other, the necessity for dragging back the hair is obviated. The relief experienced in headache by merely loosening the hair should teach the sufferer that wearing it more loosely would probably prevent such headaches. The dragging of the hair back from the forehead is one of the chief causes of thinning at the parting. Frequent shifting of the site of the parting is also a great additional precaution against such thinning. The glands of the neck are said to enlarge from the same cause. As to the selection of the mode of dressing the hair, it is a pity that suitability is not a little considered as well as fashion. The small, bird-like head, very becoming to some figures, will not suit all, and the attempt to make a large head small is as self-torturing as it is abortive. And again, while the lines of some few heads may be displayed with advantage, in the large majority of cases the broken outline of the hair will be found to challenge criticism less, especially now that the monstrous fashion of wearing artificial hair has departed, and with it the heat and headaches that it occasioned.

Some few remarks on this article of commerce may not be out of place. Amongst the various kinds, grey, light, pale, and auburn hair are distinguished as extra hair, and command much higher prices than the common shades. The value of hair increases very rapidly with increase of length. Thus, while 8 inch hair sells at about 1s. per oz., 36 inch hair realises as much as 30s. an oz., and all lengths beyond this command fancy prices. The light colours are chiefly furnished by Germany and Austria, and the south of France is the principal source of supply for the darker shades. Its cultivation among the peasant girls amounts to a trade, the traffic of which is so large as to attract to the fairs where it is for sale a set of shrewd hawkers, who doubtless drive hard bargains with the less business-like growers. Specimens are sometimes tendered for sale on these occasions measuring 5 feet or even 6 feet in length. Scarcely any of the raw material is obtained in the United Kingdom, except in the form of ladies' combings.

Light is of great importance in preserving the hair, and proper ventilation is also most essential as tending to evaporate the secretions, which otherwise, extending to the hair, become decomposed and irritate the skin. The best coiffure, then, is that which leaves the hair as free as possible, in a measure compatible with custom or fashion. Bazin says on this point that in those countries where a light hat is worn by women, as in Corsica, Spain, and the East, their hair is the richest; and he strongly deprecates enveloping the head in kerchiefs, whimples, head-dresses, and the heavy hats, made still heavier by ornamentation, and gives the preference to the bonnet (although not free from defect) as lighter and more permeable to the air. He strongly objects to the masculine skull-cap as too hot, but speaks approvingly of straw hats as being light and good conductors of heat. Of children, he says, in early days the head should be protected from exterior influences, but when the hair has acquired a sufficient development it is well to accustom them to expose the head, since this hardens the scalp and diminishes its impressionability. The boys of Christ's Hospital sufficiently illustrate the wisdom of this advice; they are to be seen hatless in all weathers, and are at the same time remarkable for luxuriant heads of hair. Sailors, again, and butchers are rarely bald.

Hair which is naturally too greasy will be benefited by washing with a little soda or ammonia, but deficiency in this respect is by far the more common condition.

Baldness.—Of the varieties of baldness, only two call for any consideration here—first, thinning of the hair, and secondly, old-age baldness, when it presents itself in early life. Where total loss of hair takes place over a limited area, it is the result of a disease termed "alopecia areata," and, requiring special treatment, does not fall within the scope of this article. The cause of loss of hair in old age is not far to seek. As the circulation becomes weaker, and the nerve control of the vessels is impaired, the hair, in common with other parts of the body, suffers from want of nourishment consequent on the general decay of nature, the roots dry up, and the hair falls off. But thinning of the hair and premature baldness are not so easy to explain. The causes are complex, and no one reason will account for the fact. Baldness is more common in men than in women, but both are alike subject to certain predisposing influences, such as heredity, debilitating fevers such as typhoid, general ill-health, neuralgia, gout, sudden shock, inflammation of the skin of the scalp, called eczema, and the general worries of life that lower the vitality. Both sexes, too, are liable to a disease known as seborrhœa sicca, the chief sign of which is the formation of dry scales on the scalp that in time causes abundant shedding of the hair—a disease requiring medical attention. Why, then, are young men bald sooner than young women? The truth is that among the upper classes, who suffer in this respect more than their poorer brethren, the habits are not conducive to hair growth, even though they may in no way affect the general health. After the morning bath the head is vigorously rubbed with a rough towel, and if this dries the hair, it is quickly wetted again in order to make it, with the aid of a pair of hard brushes, lie smooth. All this scrubbing and wetting refreshes the body, no doubt, and has a very exhilarating effect generally, but it is bad treatment for the hair, much of which is rubbed or brushed out. But this is not all. After breakfast the crown of the head is encased as with a tight band in the upright hat of civilisation, which, encircling the forehead at the temples, cuts off much of the pure blood supply intended for the scalp, and at the same time causes venous congestion by pressure on the superficial veins. It should be borne in mind that the two arteries, called temporal, passing one on either side of the head in front of the ears are the main sources of blood supply to the skin of the upper and middle portions of the scalp. Thus, during the time the hat is worn the hair on the upper part of the head is, if not starved, at least kept on short allowance. Hence it is that baldness generally begins on the temples and crown, while it rarely indeed attacks the back of the scalp, which is nourished by other blood-vessels so deeply seated as to escape pressure. The hair, however, between the coat collar and the hat, that is never covered, always remains long after the rest has been shed. But the conventional hat does more than constrict the vessels. As it possesses no means of ventilation worth the name, the skin within it soon becomes heated, and perspiration follows, which causes the hair to rot and to fall off. The closely-fitting college cap acts somewhat in a similar manner, producing that premature baldness which is usually attributed to severe mental strain. As regards the use of stimulating applications in cases of thinning of the hair, it may be unhesitatingly set down as of more than doubtful value, which somewhat qualified opinion is shared also by Dr. Pincus, although some writers have in years past strongly recommended it. The stimulants sold in the shops are usually composed of cantharides, ammonia, or spirit of some kind, and are generally far too powerful in their action.

Shaving.—The use of soap in shaving is not, as is popularly supposed, to soften the hairs, but, on the contrary, to render them hard, dry, stiff, and brittle. This is the condition in which they yield best to the blade. Every one knows the difficulty there is in cutting the usually crisp morning paper: when by chance it is damp, it invariably tears. Hair being naturally oily, were one to shave dry or with plain water, the razor would either slip over the limp hair without cutting it, or, entering about half way, bend the hair back and slice it lengthwise, all the while straining it most painfully at the root; and as a razor would thus slice and pull probably a large number of hairs at once, the pain produced would be intense. Most shaving soap, however, contains a free alkali either potash or soda, which combines with, and so removes, the oil of the hair, leaving only the hard fibre dry and stiff, as may be seen by dipping a single hair in a solution of carbonate of soda. The lather should be made with very hot water, and should be well churned up on the face with a brush, as the more creamy and the less watery it is the better will be the effect of the alkali in stiffening the hair. The hand, which is far better than toilet-glove or flannel for applying soap to the face in washing, has a function in the process of shaving. Of all razor-strops it is the very best, provided only that the razor be not permitted to touch anything but the hone. It is, however, necessary to stroke the razor some thirty or forty times on the palm on both its edges.

HAIR-DYES.

Besides the cosmetics described elsewhere, there are other forms in no less demand as hair-dyes, although as they produce their effect by simply adhering to the hair shaft, they would be more correctly described as hair paints. The art of hair-dyeing was extensively practised by many of the nations of antiquity, notably by the Persians, as well as by the ancient Greeks and Romans. The vegetable world furnished the principal substances employed in the composition of the earlier hair pigments, such as nutgalls, pomegranate bark, walnut shells, the ashes of plants and ivory black, the last two being mixed with some kind of animal fat. The Venetian ladies of the middle ages are reported to have bleached their hair by wearing it loosely spread out upon the rims of crownless hats, the effect of which exposure to the sun and air was very similar to that now obtained by the application of peroxide of hydrogen, a fairy whose aid is at present invoked, under various familiar aliases, to transform a dark head of hair into a lighter one. " Golden fluid " is but another verbal disguise for the same chemical agent. Unfortunately, however, the innocuous qualities of the ancient hair-dyes cannot be claimed for many of those of modern times. From the published formulæ for preparing the best known of these dyes, and from the evidences afforded by analysis, it may be fairly assumed that their basis is almost always metallic, and in many cases poisonous.*

On the 13th January, 1867, *The Lancet* published the results of the analyses of twenty-one of the popular hair-dyes having the greatest sale. Of the twenty-one samples, seventeen contained a salt of lead in varying but always considerable quantity. In one sample, and that not the strongest, lead was detected equal to about ten grains of the crystallised acetate per ounce. In addition to the lead salt, sulphur in suspension was also present in fourteen out of the seventeen samples. Only four of the dyes were free from lead. Of these, one was composed of an ammoniacal solution of oxide of silver and a solution of pyrogallic acid, the two liquids being in different phials, and the latter being intended, as in photography, to reduce the silver, so that, when applied, it might be deposited as a black impalpable powder on the hair. The three remaining dyes were composed of a weak acidulated solution of peroxide of hydrogen. In a recent examination carefully conducted for the writer by a skilled chemist, lead was discovered in no less than six out of nine samples of some of the most popular of these preparations. Calculating the lead in these six specimens as acetate, the first contained nearly nine grains to the fluid ounce, the second five grains, the third three and a half grains, the fourth nearly four grains, the fifth three and a half grains, and the sixth two grains. In the four first cases, precipitated sulphur was also present, whilst in two, instead of sulphur, there was hyposulphite of sodium. Most of the specimens contained glycerin, and, with the exception of one, were perfumed. The effect of exposure of these fluids when applied to the hair is that by evaporation a deposit is formed of the brown or black sulphide of lead. Pernicious as the lead dyes of the present day are by many held to be, they are, nevertheless, in point of cleanliness and expedition, a great improvement upon the old-fashioned ones. These mostly consisted of litharge, or oxide of lead and lime reduced to powder, being made into a paste with water. They were applied to the head for three or four hours, the mixture—one might almost say the poultice—being kept in position by means of an oil-skin cap or bladder. The process has not been inaptly compared, by one who had periodical recourse to it, to "putting the head into a hod of mortar." In the face of the foregoing statements with regard to modern dyes, it is not a little amusing to note that the proprietors of all these half-dozen nostrums emphatically assert that their wares are not hair-dyes, but simply "restorers," and that they contain no objectionable ingredient, merely restoring the hair to its pristine hue. Indeed, one enterprising vendor goes the length of affirming that his rejuvenising water supplies to the hair the colouring matter that nature no longer furnishes to the interior. We have been speaking so far of six out of the nine samples tested. Of the three remaining specimens, No. 1 consisted of two half-ounce bottles enclosed in a small cardboard box. In one of these bottles was an ammoniacal solution of oxide of silver, which, calculated as nitrate, contained seven and a half grains of that salt. In the other bottle was a solution of pyrogallic acid, about ten grains to the ounce. No. 2 differed only from No. 1 in the greater strength of the silver solution (this being thirty-five grains to the ounce), and in the contents of each bottle—viz., six drams. The second bottle was precisely the same as the second bottle of No. 1. No. 3 was an American preparation. The silver in this was in the condition of oxide, which was mixed with a little weak mucilage. It had fallen to the bottom of the half-ounce bottle containing it. Its equivalent in nitrate of silver would be twenty-eight grains to the ounce. In the other bottle of this sample was a solution of gallic acid of about fifteen grains to the ounce. In addition to these there was also a third smaller phial of potassium sulphide, which was recommended to be used when the lustre of the dye had departed from the hair.

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* In addition to lead and silver, which are the essential materials in the majority of these formulæ, we meet with dyes containing bismuth, copper, iron, and the potent poison perchloride of mercury, none of which, however, were detected in the samples purchased for analysis.

From these brief statistics, purchasers of hair-dyes are justified in drawing the general inference that those preparations which are sold in two bottles are preferable to those contained in but one. So long as vain people will have recourse to these supposed aids to perpetual youth, so long will adventurous and obliging druggists, perfumers, and hair-dressers come forward to meet the demand for them, and since the silver dyes are credited with harsh and objectionable properties, we recommend to both vendor and consumer, as probably the mildest and safest preparation known, the following formula for a brown hair-dye. It is the invention of an eminent and philanthropic French chemist, M. Nacquet, and very similar to one proposed, some years before M. Nacquet published his form, by Dr. Hager, a German chemist. Here are the instructions for making it, extracted from the *Moniteur Scientifique*:—"Dissolve 100 parts of bismuth in the smallest possible quantity of ordinary nitric acid (about 280 parts). To this liquor add a solution of 75 parts of tartaric acid in water, and then a rather considerable quantity of water to insure complete precipitation. The whole mixture should then be thrown upon a filter, and the residue washed with water until the washings cease to be acid. This done, the magma left on the filter is put into a dish, and a solution of ammonia gradually stirred in until all is dissolved. The magma derived from $1\frac{1}{2}$ kilogrammes of bismuth will require 0·8 or 0·9 litres of ammonia. Add to this liquid 75 parts of hyposulphite of sodium in powder, and when the salt is dissolved the product should be filtered, one or two per cent. of glycerin added, and the whole may then be bottled. Five or six hours after the hair or beard has been saturated with this liquid it will have acquired a deep chestnut colour, which upon the hair being washed with water, disappears, giving place to a delicate flaxen colour. By repeating the operation daily, a stage will at length be reached when, after passing through all the intermediate shades, the deep chestnut will remain persistent."

THE NAILS.

The nail, which is a part of the scarf skin, is firmly attached by its under-surface to the sensitive skin, or quick, by means of deep grooves and ridges, between which the true skin throws out corresponding soft ridges; so that over the whole of its length, the nail and its support may be said to be dovetailed together by a system of upper and lower ridges and furrows. In this way the sensitive layer provides the nail not only with a soft cushion, but also, through its interposing filaments, with nourishment. This structure is rendered visible, through the transparent substance of the nail, by reason of the blood circulating in the laminæ, as they are called, and so giving to them a pink appearance, which, contrasting with the colourless projections of the nail between every pair of them, presents a complete series of alternating pink and white lines. The laminæ in the half moon, or lunula, near the root, are not supplied so abundantly with blood-vessels as those beneath the rest of the nail; hence the comparative whiteness of this part. Still further inward comes the root of the nail, which is embraced by folds of the sensitive skin, just in the same way as any one of the horny ridges we have mentioned is supported on either side by the sensitive laminæ. The depth of the root varies from one-twelfth in the fingers and toes, to one-sixth of an inch in the thumb. The thickness of the nail is increased by the continual addition of cells to its under projections, the formation being precisely similar to that of the scarf skin. This has the effect of raising it up gradually out of the laminated sheath, and meanwhile, the whole surface being constantly replenished by other cells, the parts remain soft as the growth progresses. A similar process taking place at the inner or free edge of the root, produces the lengthening of the nail, cells being continually added here, which, as they enlarge, thrust forward the whole structure of the nail; and as the grooves we have spoken of work in a soft medium, the growth is accomplished without resistance. The time occupied in the entire growth of the thumb-nail is about five or six months, whereas the toe-nail, growing much more slowly, takes from eighteen months to two years. If the process of growth be interrupted, by the boot being too short for the foot, the nail will either expend its developing powers upward or out at the sides, where it will grow into the adjoining flesh. This condition is very painful, and necessitates a small surgical operation for its cure.

It requires but a slight disturbance of the process of cell formation to produce a permanent mark or groove in the substance of the nail. External injury is by no means the only cause of defective growth; any severe illness, such as fever or inflammation of the lungs, will often cause deep furrows to appear, which last until the nail has been cut down to the part. The knife or scissors should be used to pare the free edge, and the grooved-shaped ivory presser to prevent the overgrowth of the scarf skin upon the lunula. The unchecked growth of this skin produces an unpleasant and unsightly edge, which, when frayed, occasions much pain. It is unwise to trim this with a knife, as is often done; it should be pressed down, but not cut. Finger-nails should be cut round, and toe-nails square. Soap and water and the nail-brush are all that is necessary to cleanse the nail itself. The practice of removing accumulations of dirt from beneath the free edge with a knife is not only painful and injurious to the growth, but by loosening and elevating the nail, and so increasing the excavation, admits of such concretions in still larger quantities. Moreover, the scratches made with the knife form little grooves, from which it is difficult even with a brush to remove the foreign and objectionable matter.

HEALTH IN INDIA.

By Sir Joseph Fayrer, K.C.S.I., M.D., F.R.S., and Joseph Ewart, M.D., F.R.C.P.

Introductory—Routes—Best Time to Arrive in India—Best Time for Invalids and others to Leave India—Travelling—Sport, or Shikar—Clothing—Punkah, Tattie, Thermantidote—Bathing —Dwelling Houses—Food and Drink—Drinking Water—Purification of Drinking Water—Siesta or Mid-day Sleep—Shampooing or Massage—Exercise—Smoking—Meteorology—Hygienic and Sanitary Divisions—The Hills—Terai—The Seasons—Influence of Sun and Heat—Prickly Heat—Febricula—Ague—Enlargement of Spleen—Anæmia—Remittent Fever—Typhoid or Enteric Fever —Sunstroke, Heatstroke, or Insolation—Effects of the Climate on European Women—Age at which Children should be sent to Europe—Poisonous Snakes, Scorpions, Centipedes, Mosquitos, Land Leeches—Ticks—Bugs—Fleas.

Introductory.

Before dealing with matters relating to the preservation of health in India, we propose to refer briefly to some of the leading geographical and physical characteristics of that interesting country. India may be described as an irregular-shaped triangle, extending over nineteen hundred miles, from the eighth to the thirty-fifth degree of north latitude, and an equal distance at its broadest part, from the sixty-sixth to the ninety-seventh meridian of east longitude. It is bounded on the north, for upwards of fifteen hundred miles, by the gigantic Himalaya mountains, on the north-west by the Safed Koh and Suláiman ranges, on the west by the river Hab and Cape Monze, the Arabian Sea and Indian Ocean, and on the north-east and east by the Abor, Nágá, Patkoi, and Barel ranges, standing between Assam and Eastern Bengal and independent Burmah, until the nineteenth degree and a half of latitude, near the base of the Myenmateng mountain, is reached, where the line of frontier is directed due east between British and independent Burmah; it then runs in a south-easterly direction along a series of low mountains separating the British province of Tenasserim from Siam; the eastern boundary being completed by the Bay of Bengal. Within these boundaries of land and water are comprised an area of 1,500,000 square miles, and a population of 252,541,210 (*Census* of 1881)—about equal in both respects to the whole of Europe, exclusive of Russia.

If it were possible to take a bird's-eye view of this great peninsula or promontory of Asia, it might be divided into (1) the scimitar-shaped outline of the Himalaya mountains, with their subsidiary ranges to the north-west and north-east, averaging an elevation from 16,000 to 18,000 feet, including Kanchanjangah (28,176 feet) and Mount Everest (29,002 feet), the loftiest measured peak in the world, and affording on some of their southern slopes and spurs many excellent sanitaria, such as Murree, Mussooree, Landour, Nainee Tal and Darjeeling; (2) the great river systems of the Brahmaputra, Ganges, and Indus; (3) the table-land of the Deccan and the south, bounded on the north by the Vindhyá and Satpoora mountains, on the east and west by the ghats, and tapering or converging to a point near Cape Comorin.

This extensive but compact country has a teeming population composed of races more numerous and ethnically distinct, and speaking languages numerically greater and more varied than those of Europe; whilst, from the nature of its physical geography and the extent of its area, it has every kind of climate, from the torrid to the temperate and arctic zone. The seat of the most ancient civilisation, with a history reaching far back into remote antiquity; possessing a fertile soil, lofty mountains, elevated table-lands, rich alluvial valleys, extensive desert tracts and plains, noble rivers, vast swamps, jungles, magnificent primeval and modern forests; a rich fauna and flora, wealth of mineral, vegetable, and animal products, and many undeveloped resources, it has characters that invest it with peculiar interest, especially for those who spend the best part of life there, and on whom the responsibility of ruling has fallen. A country with such physical endowments has many distinguishing features that are strange to the Anglo-Saxon, who has necessarily much to learn before he becomes reconciled and adapted to his new home. The people and their habits, the animal and vegetable creation, even the diseases, differ from those he has hitherto known or heard of, and he makes acquaintance—let us hope, not in his own person—with malarial and liver disease, insolation, heat apoplexy, dysentery, guinea, worm and other filarial affections, and some maladies such as dengue and cholera, which sweep over the country as disabling or destructive epidemics; whilst the conditions of life generally under which he moves and exists are dissimilar to those that he has been accustomed to in the temperate latitude of his birth, boyhood, and youth.

ROUTES.

Those who select India for a career should be in the enjoyment of fairly good physical and mental health. As regards the civil, military, ecclesiastical, medical, educational, forest, telegraph, postal, and other public departments, this desideratum is, to a great extent, secured by the medical examination to which nominees or candidates are subjected in this country. Most of the young men who join the great mercantile houses, banks, the indigo, tea, coffee, jute, and other concerns, or the railways, have to insure their lives, and are, therefore, submitted to a similar health test, as a condition of their covenants with their employers. The majority of these, and others to whom time is important, will select one of the two shortest routes to India, viz., 1, *overland*, from London, across Europe to Brindisi and across Egypt from Alexandria by rail to Suez, thence to Bombay, the whole journey not exceeding *nineteen* or *twenty* days; 2, *by sea*, from London and Liverpool, by the Bay of Biscay, Gibraltar, Malta, and Suez Canal, completing the voyage to Bombay in about *twenty-seven*, Madras in *thirty-three*, and Calcutta in *thirty-seven* days. The latter route is largely preferred by families and all who are in impaired health, both in the outward and homeward voyage, partly to secure the benefits of a lengthened and uninterrupted sea voyage, and partly to avoid the discomfort, and wear and tear consequent on the double overland journey in Egypt and Europe, of the former route. The *long sea* route, round the Cape of Good Hope, to Calcutta, completed by steamers in about *seventy* days, or Green's sailing ships in about *one hundred and ten* days, is frequently taken by those who may have been recommended to avail themselves of a long sea voyage for the benefit of their health—especially for the correction of any phthisical proclivity, certain forms of kidney affection and chronic bronchial catarrh. It is also highly beneficial to invalids sent from India suffering from malarious cachexia, enlargement of the spleen, anæmia, hepatic derangement, nervous debility, and insomnia, consequent on a too protracted residence in hot, damp, and malarious districts. It is eminently useful to the young of both sexes going to, or returning from, India, to whom the length of time occupied in the voyage is not a matter of vital importance.

Best Time to Arrive in India.

The European should, if possible, make arrangements to arrive in India, at or near the commencement of the cold weather, or, at any rate, before its termination—say in November, and not later than January. The trying heat of the Red Sea, during the outward journey, is thus reduced to a minimum; and the transition from the autumn or early winter of this country to the genial cold season in India is found to be pleasant and healthful, whilst time is allowed, as the hot weather gradually approaches, for the partial accommodation of the constitution to the altered circumstances involved in the transfer from a temperate to a tropical climate. If, however, this be impracticable, the second best season for arrival, at most parts, under the influence of the south-west monsoon, is during July and August. But, in the event of this period being fixed upon for the voyage, the utmost care, in diet, drink, and clothing, must be taken to neutralise or mitigate the heat of Egypt and the Red Sea. Under such conditions, precautions must be had recourse to, to avoid anything like constipation, whilst the strictest abstinence from too highly seasoned food and alcoholic liquors must be enjoined.

To time the arrival in India in April, May, and June—the hottest months—or during the latter half of September and most of October—the malarious season—is often to sow the seeds of cerebral and hepatic disease, which may give considerable future trouble, embitter subsequent residence, and foster an ineradicable dislike to the country. No one in delicate health, or who is not strong and vigorous should be advised, or permitted to select these months for the commencement, or continuation of an Indian career. Even in such a case, the selection should be one of necessity rather than of choice. If, however, as will often happen, especially in the case of ladies and their children, such persons are desirous of travelling without avoidable interruption, in order to reach any of the hill sanitaria before the hot weather sets in, the most suitable period for them and others similarly circumstanced, to arrive, is in the earlier part of March. This arrangement will enable them to reach the sanitarium of their choice without encountering the trials, drawbacks, and discomforts of a long and fatiguing railway journey through the hot winds. If put off much later, the inland journey, undertaken in the fierce heat of the hot winds, is added, in quick succession, to the hardships of the Red Sea; and the combination of such a sudden transition from an English winter may be most injurious.

BEST TIME FOR LEAVING INDIA.

February and March are the best months for embarkation from any of the three principal Indian ports, especially for invalids, ladies, and children. The railways and inland river steamers now render it possible to reach these places, with expedition and punctuality, from the most remote districts. With sufficient forethought as to clothing and provisions, the longest railway journeys may be undertaken at this season in comfort and safety. River steamers are also comfortable. Another advantage is that the hotels, in which passengers may have to stay pending the departure of the homeward-bound steamer, will be found cooler, and therefore less disagreeable, than when the departure is postponed till April or May. Moreover, at this period, the nights and days spent on the voyage are not so hot as they are later on. Those who are in fairly good health, and to whom the saving of time on the way is a matter of importance, will probably travel overland, *viâ* Brindisi, with the mail. But those who are in delicate or infirm health, and all others to whom time is comparatively unimportant, will do well to select the short sea route through the canal, which enables them to travel with a minimum of interruption or disturbance to their destination. On starting from India, provision should be made for abundance of the warmest woollen and other clothing, to be utilised in the Mediterranean perhaps, the Atlantic and the Channel. Too much care cannot be exercised in thus securing the invalid, as well as those who are apparently in excellent health, against the evil effects of chill. Yet such a simple and self-evident precaution is too often neglected, and bronchitis, congestion of the liver, and recurrences of malarial fever are often the result, all of which might have been avoided.

Those who are suffering from serious tropical diseases, or who have not recovered sufficiently from their effects, will do well to dally at any of the health resorts of the Mediterranean, which may have been recommended as suitable, and refrain from coming to England, until the month of June. Before this, the climate is usually unfavourable to recovery from chronic dysentery, malarial enlargement of liver, malarious cachexia, and tropical anæmia. Whereas in conjunction with the appropriate treatment which can be commanded from English physicians practising at the southern sanitaria, sufferers are generally benefited by a stay there, until it is safe for them to proceed home. By the adoption of this course, the good effects of removal from the Indian climate and the sea voyage are maintained, and the chances of permanent restoration to health, after arrival in England, materially promoted.

Since the opening of the Suez Canal and the shortening of the overland route, the facilities offered to Anglo-Indians for visiting Europe have been much increased. Many hard-worked officials, as well as many engaged in mercantile pursuits, avail themselves of these advantages, by spending short leaves of absence at home. They may start from Bombay, in the height of the monsoon, in July or August, when railway travelling to the port of embarkation is tolerably safe and pleasant, and when the voyage across the Indian Ocean is breezy and cool, run the gauntlet of the stifling heat of the Red Sea, reach England with the mail, *viâ* Brindisi, in the autumn, and be able to return to India at the beginning of the cold weather. They thus avoid the malarious season, have the benefit of two sea voyages—one of which (the return journey) is undertaken in circumstances favourable to the preservation of health,—and of a sojourn of about six weeks in England, at the most pleasant time of the year. The short sea route, by way of the Suez Canal, is also often preferred, at this season, by those who have suddenly broken down in health, during the hot weather and beginning of the rains. But for these the long sea voyage round the Cape will often be found to be even more beneficial. The dangers to the invalid of the Red Sea in July and August are thus avoided, whilst the long sea journey, of from 70 to 110 days, in a healthy and antiseptic atmosphere, in either the well-found steamers or sailing ships now available, may be the means of saving valuable lives which would otherwise be inevitably sacrificed.

May and June, the hottest months, are not suited for leaving India, although some still do so, at the beginning of the former month, because it enables them to arrive in England in summer. But to the strongest, the voyage at this season is very trying—often to those in infirm health, fatal, especially in the Red Sea. Moreover, excepting, perhaps, to the favoured few, who may be able to have their carriage artificially cooled by tatties and who are supplied with abundance of ice, the risk of a long railway journey to reach the port of embarkation, in these months, from sunstroke, heat apoplexy, and exhaustion, is very great. The danger is much diminished in the temperate and robust, for these, as we observe in the tiger-shooting expeditions undertaken in April, May, and June, in the hottest parts of the empire, can stand prolonged exposure to intense heat, with considerable impunity, provided the head and spine are thoroughly protected. Still, we have known the strongest and most temperate, to all appearance, seriously injured in health; even teetotalism or temperance will not always save them from succumbing to such intense heat. The danger is immensely increased by intemperance in eating or drinking. So it is in a journey across India, and thence to this country, in May or June. The climate of India during November, December, and January is so agreeable and salubrious that few who can remain leave it during these months.

Travelling.

Travelling in India during the winter months, has become much easier and more agreeable, since the construction of the railways connecting all the important parts of the Empire. There are nearly *ten thousand* miles of railroad in working order. Calcutta is in unbroken communication with the frontier outpost of Peshawur at the mouth of the Khyber Pass, covering a distance of *sixteen hundred* miles. Bombay is, in like manner, linked to Madras, Calcutta, Allahabad, Agra, Delhi, Lahore, and Peshawur, whilst a number of minor feeding lines are either finished, or under construction. By means of these and river steamers, supplemented by bullock or horse dawks &c., Anglo-Indian officials or gentlemen engaged in agricultural, mercantile, or mining enterprises are safely conveyed to their destination in the interior from the three principal ports of disembarkation—Bombay, Madras, or Calcutta—during the monsoon and winter months. Those employed in Cachar or Assam are carried to their occupation in the tea-gardens partly by rail, but chiefly by river steamers at the same seasons. The tourist, who has only one cold season at his disposal, would do well to so arrange the journey that he may reach Galle or Colombo in Ceylon about the end of October or beginning of November. Having exhausted Kandy, Newera Eliya, the coffee, tea, and cinchona plantations—and refrained from snipe and elephant shooting, at this period, on account of the risk of catching fever—he should go by steamer to Madras, which is usually reached in three days. Thence, he may travel by rail to places of interest in the interior, not omitting a visit to the Shevaroy and Nilgherry mountains. Re-embarking at Madras, he ought to find himself—after a pleasant sail of four days up the Bay of Bengal becoming daily more agreeable as he steams farther north in the teeth of the north-east monsoon—in Calcutta, appropriately styled the City of Palaces, probably about the end of November or the first week of December. Thence, he may proceed, after having seen the lions of the metropolis of British India, by rail to Darjeeling, from which, at this season, the views of the snowy range of the Himalayas are as stupendous and entrancing, as they are unrivalled in elevation, grandeur, weird beauty, and magnitude. He should not fail to secure a view at sunrise from Senchal, the highest point of Darjeeling; and if the sky be clear, he will observe, facing north and inclining the eye a little to the left, the sugar-loaf-shaped peak of Mount Everest, 29,002 feet above the level of the sea—the highest mountain in the world; in front, and almost due north, Kanchanjunga, 28,176 feet high; and turning to the right, a number of other snow and ice-clad ranges, not one of which is less than from 20,000 to 22,000 feet in height: he will probably look down upon a sea of dense mist and cloud—shutting out the immense intervening valleys, with their glorious primeval forests, from view; above, he will note, *en masse*, dense forests, in an ascending order, of magnolias, tropical oaks, pines, and tree rhododendrons, up to an elevation of twelve or thirteen thousand feet; higher still, gigantic glaciers unparalleled in size; and, beyond, perennial ice and snow, until the attention is riveted by a play of rainbow colours resting on the crests of Kanchanjunga and other peaks just as the sun is rising above the horizon. After he has done all this, and, perhaps, had some snipe-shooting in the plains below, well removed from Terai, he should return to Calcutta for a fresh departure about the beginning of the year.

He has now, in genial weather, the whole of the Gangetic Provinces open to him, with all the facilities afforded by the East Indian Railway to speed him on his way. He may, therefore, in rapid succession, visit Patna, Benares, Allahabad, Cawnpore, Lucknow, Agra, Secundrabagh, Futtehpore Sikree, Jeypore, Ajmeer, Delhi, Lahore, Mooltan, Peshawur, and, perhaps, Simla or Mussoorie, or both. Returning in February to Allahabad, he may take the train to Jubbulpore, with the intention of inspecting the marble rocks in the vicinity; continuing his journey across India, he may visit Nagpore on the way to Bombay; whence he should not fail to visit the Towers of Silence, Caves of Elephanta, Matheran, Lanowlie, Poona, and Mahableshwur, and be ready to leave for Europe about the middle of March.

Should the tourist or traveller be desirous of having some tiger-shooting, he will have to prolong his stay into April or May, when the long jungle grass, which at other seasons affords cover, inaccessible and impenetrable, has either been withered or burnt up by the scorching sun. After this has been accomplished, he may either resume his homeward journey, during the monsoon, or spend the rainy season at Simla, Mussoorie, Darjeeling, Nilgherries, or at the comparatively cool stations of Poona or Bangalore. This latter alternative would enable him to visit Cashmeer at the end of the rains, or to extend his exploration in the interior of the peninsula during the ensuing winter months. Travelling across India is safe and congenial during the cold season, from October to February or March, in Bengal or Bombay; and from September to April in the North-west Provinces and Punjaub. Dust is the chief inconvenience and source of personal discomfort. It is safe and, perhaps, more pleasant in the rains, because there is less dust. During May and June, it is exhausting, and excepting in carriages artificially cooled by means of khuskus tatties, there is much danger from heat apoplexy, not to mention cholera, especially in the endemic area of Bengal. Moreover, the dust is intolerable.

It is important that the traveller and others should, if possible, avoid visiting Calcutta, "the home of cholera," during the transition from the cold to the hot weather in the months of February and March. It has been noted by the most experienced observers that new comers are specially liable to be attacked by the disease at this season.

Sport or Shikar.

Quail, snipe, woodcock, partridge, sand grouse, wild duck, pheasants, wild geese, peacocks, bustard, hares, and the larger kinds of game, such as deer of all sorts, the antelope and black buck, &c., leopard, panther, tiger, lion, bear, rhinoceros, buffalo, wild pig and boar, and wild elephants, may be found in suitable places in different parts of India, offering unequalled opportunities for the employment of gun and rifle, and what is called "pig-sticking." We, therefore, recommend every young man going to India to include in his outfit a good gun and rifle, the use of which, in the pursuit of small and large game, tends much to the preservation of physical and mental health, provided due care be taken to minimise the effects of malaria and the sun. We insist upon this proviso, because much mischief is constantly done by neglect of those simple but essential precautions, which, as experience demonstrates, cannot be ignored with impunity. Writing from considerable experience, we believe that snipe-shooting, especially in Bengal and Bombay, should not be attempted by the Anglo-Saxon resident or traveller before the month of November. As the rainy season ceases, the jheels and swamps swarm with snipe, and the enthusiastic and ardent sportsman is unfortunately unwilling to miss the opportunity of availing himself of the sport thus afforded. But, at this season, and for some weeks after the cessation of the monsoon, malaria is generated in profuse abundance in the localities frequented by snipe, wild duck, and wild geese; and malarious fevers prevail among all classes of the neighbouring community. Hence the danger of snipe-shooting at this season. Much ill-health is thus occasioned, and many lives sacrificed, during this period. As in the upper provinces, Punjaub, and Rajputana, the monsoon is over earlier—generally by the middle of September—and the drying-up and malarious season is terminated proportionately early, snipe-shooting in the swamps and jheels of the plains may be commenced in these localities about the latter half of October. But in the Terai, or in the close neighbourhood of the same, it is not safe much before February or March, after which, owing to the increasing heat, the snipe migrate towards Thibet and Central Asia.

While engaged in this sport, water-proof boots reaching above the knees, flannel next the skin, khakee or brown over-clothing, a substantial, well-ventilated, solah topee, or felt helmet, and a pad of cotton or cork—four or five inches broad and twelve or fourteen inches long—to protect the cervical and dorsal parts of the spine, should be worn. Then, as to the time of the day, the sportsman should start after a moderate but good breakfast about eight o'clock in the morning, and shoot up to ten or eleven o'clock ; retire, and after luncheon he may resume sport about two or three o'clock, until five in the afternoon. Thirst is best quenched by cold tea. No alcoholic drink should be indulged in, whilst the sun is above the horizon. Indeed it is better, even at dinner in the evening, to avoid it altogether. All drinking water should be boiled and filtered. In camping the sportsman should have his tent pitched on high ground, as far removed from swamps as possible. By the recognition and adoption of these simple and necessary precautions, snipe-shooting may be pursued with a maximum of advantage and a minimum of risk in any part of India. The European must never sleep in the Terai during the winter and rains, nor in autumn.

Deer-stalking, fox and jackal hunting, are usually carried on in the winter months; and so is rhinoceros shooting in the jungles of Assam and Cachar. The period generally selected for tiger, panther, leopard, and bear shooting is the hottest season, during April and May. The cover previously afforded by long grass, &c., is now to a great extent burnt up or withered by the fierce heat of the sun; water is diminished, and these animals, having to travel from their lairs or caves in search of food and water, are marked down by the tracker or shikaree with comparative facility. This want of shelter enables the shikaree and sportsman to see them at a greater distance, thus giving time for prompt deliberation, and the rapid concerting of whatever measures may be deemed needful, whilst adding materially to their safety from a sudden and unexpected attack or charge. In Bombay and Madras, the pursuit of these feline animals is conducted on foot; in Bengal, on elephants. There is a certain amount of danger from their charging their adversary, particularly when irritated and exasperated by wounds which are not immediately fatal. The chief enemy, however, is the direct action of the sun by day, and the still, stifling hot air by night. The best way of fighting these dangers is by rigidly observing the precautions already adverted to in disposing of the question of snipe-shooting for the thorough protection of the brain and spinal marrow against the direct rays of the sun, by alleviating the thirst either by means of cold weak tea or wholesome water cooled, if possible, by means of ice; by teetotalism or, at any rate, the strictest temperance in eating and drinking, especially the avoidance of all alcoholic beverages, until after the sun has passed below the horizon; and by cold-water bathing before breakfast daily, and, perhaps, before dinner too. The malaria, which is even a greater danger in snipe-shooting than the sun, is in April, May, and June non-existent, and is out of account in tiger, leopard, panther, and bear shooting.

CLOTHING FOR USE IN INDIA.

The apparel should be suitable to the climate and the seasons. *At all times light flannel specially made should be worn next the skin.* Over this, it is also better to wear tweeds, such as are manufactured for hot climates, rather than cotton fabrics. The former, to a certain extent, keep out the heat, readily permit the absorption and evaporation of sensible perspiration, help to maintain an equable temperature and circulation of the skin, and thereby lessen the risks of sudden suppression of the cutaneous exudation; whilst the latter, during exertion, or sometimes without it, in very warm weather, and particularly when extreme humidity is associated with heat, become matted and wetted with profuse sweat, and so promote, on exposure to draught or even the punkah, the too speedy reduction of the temperature of the skin with the development of chill. If, however, white cotton or linen overclothing be selected during exposure to the sun or to intense heat indoors, it should always be used over a substratum of woollen clothing. It should be borne in mind that however hot the sun's rays or the atmosphere may be, sudden depressions of temperature may occur, and under such circumstances, when the cutaneous circulation is active and the perspiration exceedingly free—it may be profuse—sudden check of it is often followed by internal congestion of the abdominal organs and numerous other evils. Hence the cardinal importance of woollen underclothing, at least to Europeans of both sexes and all ages, and the superiority of thin light tweeds to cotton or linen for the outer garments. As the digestive organs are much predisposed to derangement, the wearing of the so-called cholera belt, or a band of flannel, in addition to the usual apparel, is a precaution of superlative value.

In the winter months north of the Nerbudda, and of the Delta of the Ganges, and throughout the year at all the hill stations of the first class, the under and outer-clothing must, to be effective, be almost quite as substantial as that worn in Europe. For, though the temperature is not so low excepting sometimes in the more elevated Himalayan sanitaria, the diurnal variation at certain seasons is very considerable, and the *feeling* of cold is excessive—necessitating before sunrise and after sunset very warm clothing. A woollen night-dress or sleeping suit, modified according to season, is essential.

In very exceptional cases, and especially during the rainy season in the humid and steamy climates of Calcutta and Bombay and similar climates, the lightest and thinnest flannel cannot be worn, on account of its aggravating the itching and irritation caused by lichen tropicus or prickly heat. But in such cases the finest porous silk fabrics, which are cooling and form an admirable protection against external heat and chill, can usually be tolerated, and they form a tolerably efficient substitute for woollen underclothing. These silk vests, however, are much more expensive than flannel. Where the preservation of an even temperature of the skin and the consequent prevention of chill are in question this objection should not be allowed, whenever the cost can be met, to weigh against the advantages secured.

On making inquiries we have been surprised to find how seldom European ladies wear woollen or silk next the skin during residence in India. This arises from the use of the corset, which is warm and oppressive particularly in hot weather; but it leaves the upper part of the chest and the lower part of the body unprotected. Tight lacing is injurious everywhere; it is very hurtful in hot climates. As a matter of fact, the evil practice is less adopted in the East than in temperate climates, for the simple reason that the discomfort is so great, from perspiration and prickly heat in the rainy season and breaking up of the monsoon, that it cannot be tolerated. A corset just sufficient to give the required support, so light and porous as not to interfere with the wearing of light flannel or silk next the skin, and capable of being adjusted without producing undue pressure on important parts, for ladies in India is, we believe, still a desideratum, the want of which is unquestionably the cause of some of the ill-health from which they suffer. We have often traced sickness in ladies from attending balls in low dresses and returning home overheated and exhausted without adequate covering. Chills are also often contracted by their sitting in low dresses at dinner parties under a punkah fitfully pulled. The remedy is obvious enough.

For infants and growing children, light flannel underclothing is in more general use. At all periods, modified to suit the seasons, it is of the greatest benefit, but most essential during the time the child is being suckled, and during the process of dentition, when the child is more than usually liable to intestinal disorders. In infants the flannel garment should cover the whole of the trunk and the extremities. When the child has learnt to walk, this protective covering is made of two parts—a vest to envelop the trunk and arms, and drawers which are made to be joined to the lower portion of the vest by means of buttons. A sleeping suit constructed in a similar manner is essentially necessary, and this should be fastened tightly enough at the wrists and ankles to prevent its displacement during the hours of sleep.

A great deal of unnecessary expense is often incurred in this country in the procuring of outfits for gentlemen. It is, of course, needful to take out a sufficiency of underclothing to admit of a daily change after reaching the Mediterranean; but a couple of suits made of tweed and substantial enough for wear during the cooler part of the voyage, and a third of the lightest tweed or serge for use in Egypt, the Red Sea, and the Indian Ocean, with a heavy and light overcoat, and a couple of evening suits—one for cold, the other for hot weather—are quite sufficient. A pattern morning suit—one that may have been in use—and patterns of underclothing, will enable the new-comer to have clothes made up on the spot, as they may be required, by native tailors, who enjoy a well-founded reputation for making such wearing apparel with scrupulous accuracy from patterns. A good helmet, and blue, green, or neutral-tinted glasses are also necessary.

THE PUNKAH, TATTIE, AND THERMANTIDOTE.

During the hot weather and rains, the use of the punkah, night and day, contributes materially to the maintenance of health. It consists of a framework of wood, suspended from the ceiling with a fringe of cotton or other cloth, which is swung backwards and forwards by means of a rope passing over a pulley and pulled by a coolie. By putting the air in motion, it communicates a feeling of comfortable coolness, without which, in some parts of India, the heat would hardly be endurable. Evenly worked, without noise, it promotes sound sleep, which would often be otherwise quite unobtainable. In May and June, in those parts where the hot winds blow, the tattie, or thermantidote, or both are employed to reduce temperature. The tattie is a light framework usually made of spelks of bamboo fastened together by twine, covered or thatched with the fragrant khuskhus grass, and fitted into a doorway facing the direction of the prevailing hot wind. In the day-time, when the breeze is blowing, it is kept constantly moistened; the rapid evaporation caused by the passage through it of a quantity of dry air, at a high temperature, cools the air, as it enters the room. The thermantidote is a more elaborate machine fixed to a tattie, with a series of fans inside moved by the rotation of a wheel. When the machine is in action, the hot air thus sucked in is cooled by passing over and through the interstices of the khuskhus. The tattie is sufficient when the wind blows steadily; but when it lulls, as it generally does at nights, and often does so during the heat of the day in some localities—in the Berars and Oude, for example—the desired effect must be secured by the supplementary operation of the thermantidote.

By this simple contrivance, the fall of temperature due to the evaporation produced by a current of hot dry air passing over the grass was so considerable that in May, in Oude, with a west wind, the thermometer stood in the shade at 104°, in the house at 83°, and behind the tattie at 68°. No one should sit, under punkah, tattie, or thermantidote, in underclothing saturated, or wetted with perspiration. The clothing should be cast off, the skin dried and rubbed with a towel, and protected by scrupulously dry woollen garments—a procedure as healthy as it is refreshing. Many illnesses are the result of a neglect of this simple but effective hygienic measure, as many are prevented by its adoption. Draughts and currents of air are courted by Europeans in the summer and rains. To do so, or sit under the punkah, tattie, or thermantidote, without recognising this precaution is to provoke chill, consequent internal congestion, and functional derangements, which, if often repeated, may light up serious disease. Young persons, in the full vigour of health, are apt to despise the warning here given, but, writing after much personal experience on the spot, we can assure them that its importance can scarcely be overestimated. Often have we seen a few minutes of unguarded exposure to draughts, tattie, and punkah, in underclothing wringing with perspiration, and the laying aside of the woollen sleeping suit at nights, because it is hot and oppressive, lay the foundation of serious mischief.

BATHING.

The skin acts so freely in tropical countries that, for cleansing purposes alone, daily ablution becomes a necessity. But it also has a cooling effect, and, by reflex action, invigorates the circulatory and nervous systems. Whether the water employed should be cold, and, if so, how cold, depends upon what is termed the power of reaction, or the immediate re-establishment of free cutaneous circulation without any remaining internal congestion, as manifested by a genial and pleasant glow of warmth over the surface generally, accompanied by exalted spirits, a genuine feeling of exhilaration, vigour, and greater capacity for mental and physical work. Such is the agreeable and beneficial influence of cold bathing upon the healthy and robust European, that it may be persevered in so long as this effect is experienced. When, however, instead of these encouraging indications, reaction is delayed or imperfect, the vessels of the skin continue too long constricted, whilst those of the internal organs remain distended or congested, attended by a sensation of fulness in the head and abdomen, faintness, tightness over the chest, difficulty of breathing, depression, and diminished ability for intellectual and corporeal exertion, the cold bath is prejudicial to health, and must be discontinued. Such is very frequently the result of the practice in those endowed with the melancholic, lymphatic, and nervous temperaments; in those possessing weak nervous and circulatory systems; in those who have suffered from insolation or malarious fevers; and in all who are the victims of functional and organic disorders of the cerebral, thoracic, or abdominal organs. For these persons the water used should have the chill off, be tepid, or even warm, according to the power of reaction experienced. The temperature of the bath for this class—constituting a very large proportion of European residents in hot climates—must be so regulated as to permit of speedy reaction. Whatever the temperature may be, the washing, cleansing, soaping, rubbing down, and drying should be completed as expeditiously as possible. The best way of taking the daily cold bath is to soap the surface all over by the aid of tepid or warm water, and then to wash off the products by pouring in rapid succession two or three jugs of water over the head and body. The same method may be adopted for the tepid bath. This is better than getting into a full-length apparatus, and running the risk of remaining in it too long. There is not the same objection where only the warm bath can be safely had recourse to. But, as even here the aim to be accomplished is cleanliness and a general tonic or bracing effect, the sooner the process is completed the better. The swimming bath, or bathing in the sea, lakes, or rivers before the sun rises or in the early morning, are all beneficial to the young and strong retaining the power of ready reaction; but care should be taken not to remain too long in the water, and to see that it is free from sharks, alligators, snakes, leeches, and other noxious and objectionable creatures, and that, when headers are taken from spring-boards or other elevated positions, the depth of water plunged into is sufficient to prevent accident or injury. Lives have often been sacrificed by neglect of such a simple precaution.

DWELLING HOUSES.

These are usually constructed with special reference to the climate. The rooms are large and lofty, with high doorways and windows for natural ventilation. The walls are thick, and before the mutinies they were generally in the Mofussil, roofed with a substantial layer of thatch, which answered the double purpose of keeping out the heat and the rain. Since then the non-inflammable tile has been in more general use. The site should be well drained, and removed, as far as possible, from damp and swampy ground. The front should always, if practicable, face the prevailing wind; and on this aspect, there should be a good wide verandah, in which it is delightful to sit in the cool of the evenings and mornings. In the districts, raised chabutras—squares or circles of masonry covered with cement—for open-air use in the early mornings and evenings adjoin many houses. Kitchens, out-offices, and stables are detached at a good distance from dwelling houses. The dry system of conservancy is in use throughout the rural districts, or Mofussil. Even in Calcutta, where the English system of sewerage has been constructed, we believe, that few of the inhabitants have connected their houses with it, in the manner adopted in this country. Unfortunately, one-storied bungalows prevail in most stations. A second storey is, however, desirable for sleeping purposes. To this, and indeed to all the rooms, glass windows should be attached, to keep out draughts during the unhealthy and cold seasons. They should also be provided with Venetian doors to admit of a free circulation of air, when required, and at the same time to shield the rooms and inmates from sun and glare.

FOOD AND DRINK.

The diet should be plain and simple. New arrivals should abstain from much animal and stimulating food with a view to avoiding plethora, dyspepsia, malassimilation, and congestion of the already over-taxed liver and eliminating organs. Curries, as generally prepared, should be sparingly consumed. It is not advisable to copy the natives in respect of diet. Neither the mode of living, nor the quality, nor the quantity of the aliment can be changed with impunity. The stomach of the Anglo-Indian will no more obtain from the dietary of a Hindoo all that is necessary for nutrition than it could in other circumstances from the blubber that delights, whilst it nourishes, the Eskimo. Habit in these things becomes hereditary, and Europeans are not well adapted to sudden changes. But by degrees the food may be modified to suit altered conditions of climate.

As a general rule people eat too much in India—more than they can assimilate, or is needed for nutrition. The consequence is disordered digestion, faulty assimilation, derangement of liver and bowels with defective elimination, and excess of effete matter in the blood. A cup of chocolate, cocoa, coffee, or tea, may be taken before starting for the morning ride or walk ; a plain breakfast of the same, with bread and butter and eggs, or a little bit of chicken (more is not often needed than the bread and butter); luncheon or tiffin at 1 or 2 p.m., with very little animal food; a cutlet or the leg of a fowl with vegetables will suffice; and a glass of light wine or bitter beer, if some stimulant must be taken; but for young men and women it is quite unnecessary. Tea and indigo planters and others much engaged in the open air in the Moffusil make a more substantial repast. The *chota hazri*, or small breakfast, taken before starting for the morning exercise and work, has to last them until they return late in the forenoon, when they bathe and settle down to what is really breakfast and luncheon combined; after which they attend to office work in the afternoon. The evening is the best time for dinner—the principal meal of the day. It should be plain and simple, with as few dishes as possible. Nothing can be more prejudicial than a great variety and number of highly-seasoned courses. "To leave off with an appetite" is a good maxim in temperate countries, and better still in tropical. It is not needful to discuss particular articles of diet; but it may be generally stated that temperance, both as regards food and drink, is of cardinal importance.

As to wine, beer, and spirits, freely admitting that there may be circumstances in which they are required, and recognising the fact that a certain quantity is often taken with pleasure and benefit by some, we would also say that their use is, at the best, an acquired habit or want not originally existing in healthy young men and women; and that, whatever may be said on other grounds, it cannot be regarded as an absolute necessity for them at least. There can be no doubt that rigid temperance and abstinence in the early years of residence, or until the moderate use of alcoholic stimulants has been prescribed by the physician, is calculated to promote health and longevity in hot climates. Supposing, however, that some alcoholic stimulant be deemed necessary, light claret diluted with water that has been chastened and purified by boiling and filtering, is the best, or a glass of beer taken always with food. Much injury is inflicted upon the liver and digestive organs by excessive draughts of beer, and of spirits in the form of brandy and soda, popularly styled "pegs." The recent custom of drinking whisky and potash-water exercises an equally injurious effect upon the kidneys. We wish it to be clearly understood that we do not advocate alcoholic stimulants except as medicine, and in firmly adhering to this opinion, we believe we are right.

In the common apology or excuse that the alcohol is used to correct the supposed deleterious properties of unwholesome water, we have little or no faith. We repeat that, if a stimulant must be taken, it ought to be of the lightest, purest, and simplest kind, always consumed with meals, and never, under any pretext, before lunch or tiffin. To postpone its use until the dinner hour in the cool of the evening, after the effects of the sun and the heat and toil of the day have passed away, is better still. Cold tea—not too strong—is an excellent beverage to relieve thirst and support strength during the fatiguing expeditions of the huntsman and sportsman. Heavy tiffins with beer, champagne, brandy and soda, are as destructive of sport as of health. When, as in snipe shooting, swampy places are visited, the sport should be carried on in the early part of the forenoon, or later part of the afternoon, and care should be taken after it is over to change all damp clothing. If, with the observance of these precautions, the head and spine be thoroughly protected from the direct rays of the sun, and a prophylactic dose of quinine—two or three grains—be taken night and morning, the heat and exposure may be endured with a fair chance of escaping mischief. The exercise, and the utter relaxation and freedom from the cares and anxieties of business, involved in the pursuit of game, help to develope the physical and mental energies.

DRINKING WATER.

The quality of the drinking water is of immense importance, and requires particular attention, especially in tropical climates, where, from the prolific abundance of animal and vegetable growth, and the want of a proper balance being maintained between the processes of organic life and putrefactive decomposition, as also from defective sanitary arrangements, the water is ever and anon liable to become contaminated with noxious compounds. In addition to organic sources of pollution, it is sometimes rendered unwholesome by containing excessive quantities of chloride of sodium and nitrate of potash. A few practical observations on the different kinds of water obtainable, and on the ready methods of purifying them, may not be unacceptable.

1. *River water* holds in solution mineral and organic compounds, and in suspension vegetable and animal organisms, decomposing mineral and organic matter. 2. *Well water* holds in solution a certain proportion of every soluble substance with which it may have come in contact, during its downward passage through the pores and crevices of the earth's crust. Its mineral and saline constituents are similar in kind to those found in river water though in smaller quantities. The great distinguishing characteristics of well water are the abundance of bicarbonate and sulphate of lime that it holds in solution, and that cause its *hardness.* The comparative excess of these earthy salts is not usually deleterious to health. 3. *Tank and lake water* is merely a modification of river water. It is, perhaps, a little softer. 4. *Rain water* is often collected, during the monsoon, in large earthern jars for separate households. If the jars be carefully closed, and opened only as required, this forms a valuable potable water in all the malaria and cholera-stricken districts. 5. *Marsh water* is tank or lake water surcharged with organic matter—algæ, confervæ, infusoria, filarial organisms, &c., and, according to local tradition, the poison or germs of malarious fever. It evolves sulphuretted and carburetted hydrogen and carbonic acid gas ; the two first-named give to it its disagreeable odour. It is utterly unfit for human consumption.

PURIFICATION OF DRINKING WATER.

All drinking water should be boiled to destroy living organisms, and then filtered. The result with respect to river, well, rain, tank, and lake waters should be a moderately soft, clear, sparkling, odourless, and colourless crystal. But ebullition and filtration cannot be depended upon for removing sewage contamination, excess of ordinary organic material, and the nitrate of potash and chloride of sodium of tidal and brackish water. *Distillation* is a successful, though costly, method of purification. Distilled water so obtained, even from sea-water, is largely used by the navy and mercantile marine, within tropical regions, to protect their crews and passengers against cholera and bowel complaints. And there can be no doubt that the risk of catching these and allied diseases would be materially diminished, at such stations as Quetta and Dehra Ghazi Khan, where the water is brackish and disagrees with the European new-comer, if it were rendered pure and wholesome by the adoption of this process.

Alum is extensively used to clear the muddy waters of the Indus, Ganges, Brahmaputra, Irrawaddy, and Godavery, &c., where they are not seriously impregnated with sewage issuing from large cities, or contaminated with tidal influences. It acts in this way : the sulphuric acid of the alum deserts the alumina to combine with the lime (of the carbonate of that base) existing in the water. The carbonic acid thus liberated escapes into the surrounding atmosphere, and the alumina, being insoluble, is precipitated in flakes, which carry down with them all suspended matters, such as mud, animalcules, &c. The sulphate of lime thus formed is retained in solution, and the water is, in consequence, increased in hardness and palatableness. By decanting the supernatant liquid, a very transparent crystal is obtained. It will be perceived that whilst, by the addition of alum, all suspended materials are carried down to the bottom of the vessel, the sulphate of lime is increased in quantity. But, unless this salt exists in great abundance, it probably does not operate so rapidly as to be injurious. If, however, it be present in large quantity, it must prove so by diminishing the solvent power of the water during digestion. More than *two* or *three grains* of the alum should never be added to a quart, or *eight or twelve grains* to a gallon of water.

The seeds of the *Strychnos potatorum* (*Vern. Nirmullee, Induga, Titancotta, Beng. and Hind.*) are much used by the natives for clearing muddy water. " One of the seeds is well rubbed for a minute or two round the inside of the vessel containing the water, generally an unglazed earthern one, which is then left to settle ; in a very short time the impurities fall to the bottom, leaving the water clear, and, so far as I have been able to learn, perfectly wholesome " (O'Shaughnessy). Its mode of action has not been satisfactorily determined.

The water in uncovered tanks and wells may be purified and kept sweet, to a great extent, by planting in them the *Pistia stratioides*, or *Vallisneria spiralis*, which succulent and rapid-growing plants derive their nutriment from the organic matter in solution.

When water contains excess of carbonate of lime, as in many districts where goitre prevails, this excess may be removed either by boiling, which drives off the carbonic acid, and a proportionate amount of the remaining insoluble carbonate is precipitated, or by Clark's process, which consists in adding lime to the water. The lime unites with the excess of carbonic acid in the water, and forms carbonate of lime, which precipitates along with that previously held in solution. These simple processes have no effect on the gypsum or sulphate of lime. Contamination with lead or other mineral derived from pipes is not yet to be much feared in India, excepting, perhaps, in the capitals of Calcutta, Madras, and Bombay, where waterworks and a corresponding distribution on a large scale exist.

Aerated waters—potash, soda, &c.—though in great demand, are unfortunately not always made from the purest of water. They are greatly enhanced in value—as also is ordinary potable water—by being cooled in the hot season and rains with ice, which is either made artificially on the spot, or imported from America. Ice may be freely consumed. When the constitution is prostrated by the sun or extreme heat, or exhausted by physical and intellectual exertion in a hot and damp atmosphere, a glass of iced water slowly swallowed is far more refreshing than the iced brandy or whisky peg, or draught of beer too frequently indulged in under such circumstances. We have no recollection of ever having seen any one suffer from iced water, iced soda, or potash water taken in moderation. During the great heat of an Indian summer and rains, such drinks are highly beneficial, inasmuch as they quench thirst, whilst they refresh and cool the body.

The importance of a wholesome potable water is so great that we have deemed it necessary to treat the subject at some length; for it is so essential to the preservation of health that any deviation from the utmost attainable purity of it is a step assuredly tending in the direction of disease and premature death.

MID-DAY SLEEP, OR SIESTA.

In India and other hot climates the tendency to indolence or lethargy is promoted by the heat, whether dry or moist, and more particularly by a hot, muggy, humid atmosphere, as in Calcutta, Dacca, or Bombay. To yield too much to this feeling, which only requires encouragement to degenerate into a confirmed habit, is injurious. If the moderation in diet, and abstinence or strict temperance which we have enjoined, as regards stimulants, be rigidly enforced, the difficulty of resisting the siesta, which is rather a luxury than a necessity in the case of every one in the enjoyment of fair, average health, is considerably diminished. Whenever the ordinary occupation is insufficient to keep the body and mind fully engaged, some special pursuit should be devised to ward off the habit of indolence and to foster the development of the physical and intellectual powers. The pretty constant occupation of body and mind, during the working hours of the day, varied as indicated, and by a fair amount of outdoor exercise, recreation, and amusement, will assist in perfecting the function of every organ and part of the economy, and in promoting that sound sleep at night, which is essential to the maintenance of a high standard of health.

Anglo-Indians, who are fully employed, and sleep only at night, as a rule, do more and better work, and enjoy better health, than those who yield to the enervating influences of the climate, and give way to the *siesta*. Indeed, there is reason to believe that the sleepless nights of many are frequently caused by excess of food and drink, and consequent portal and cerebral plethora maintained by devotion to sleep at irregular periods. If, however, repose, during the hours appointed by nature, be disturbed by the insidious operation of heat, humidity, and malaria, in spite of regular work, exercise, &c., there is indicated undue excitability of brain, the sovereign remedy for which is not the mid-day sleep or narcotics in any form, but removal, for a time, to the hills, or to Europe.

SHAMPOOING OR MASSAGE.

This is an oriental institution, which may be assimilated by every one with benefit. By its adoption, the circulation is quickened and the muscles exercised with a minimum of stimulation of the nervous system. The process is grateful and exhilarating. It is usually—at least among Europeans—carried out just after the morning exercise, before taking the bath, and before going to sleep; but when, during great heat, the lower extremities ache from a sluggishly-conducted circulation, and there is a sense of weariness, it may be had recourse to with benefit at any period of the day or night. The kneading and rubbing is conducted quickly and vigorously by a servant, called a bearer, from below upwards, until almost every part of the body, anteriorly and posteriorly, has been thoroughly subjected to the process. The legs and arms may be shampooed in the sitting posture; but the recumbent and decumbent positions are needed when the entire body has to be overhauled. The ayah, or female servant, performs this service for European ladies.

EXERCISE.

Persons who live temperately, go to bed and rise early, avoid excesses of all kinds and take regular out-of-door exercise, enjoy the best health in tropical countries. In no other part of the world are late hours and dissipated habits so prejudicial. The European will do well to retire to bed not later than nine or ten o'clock, and rise not later than five in the hot and six in the cold weather. Having taken a cup of coffee, chocolate, or tea, with a rusk or a captain's biscuit, he should lose no time in sallying forth, weather permitting, for a constitutional. Some prefer walking, others combine walking with driving, whilst most who can manage it go out on horseback for a canter or gallop. Of all forms of exercise, none equals riding on a smart, cheerful, and springy Arab or Australian horse. Even in riding a horse without company, there is never the feeling of wearisome monotony attending Anglo-Indian pedestrianism. A good animal, which always responds with alacrity, as if almost to anticipate the wishes of his master, may be regarded in a measure as a companion. In walking—if we except the early morning and evening of the cold months—the body gets overheated, smothered in perspiration, and fatigue is soon experienced; but a much greater distance may be covered, far more fresh air enjoyed, and more real exercise obtained, in the cool of the morning and evening, in riding, not only without a sense of fatigue, but with a positive feeling of exhilaration of body and mind. Moreover, there is reason to believe that the higher stratum of air utilised on horseback and the current created in cantering, galloping, or trotting are highly beneficial. In either case, whether riding or walking be adopted as the mode of securing daily exercise, anything approaching weariness, exhaustion, or fatigue should be avoided. The head should be adequately protected, and unnecessary exposure to the sun prevented.

We have noticed that tea, coffee, and indigo planters, who are temperate, keep early hours, and are out much in the open air on horseback, enjoy exceptionally good health in India. For hard worked and sedentary officials, mercantile men, bankers, tradesmen, and others confined to their desks, during the working hours of the day, a brisk ride, in the morning or evening, or both, is in every way most conducive to the maintenance of health. It is equally suitable for children of ages from four to six and upwards, to young and married ladies. The introduction of croquet, badminton, and lawn tennis has contributed much to the improvement of the health of ladies and gentlemen in the plains. Cricket, football, running in moderation, and rackets in the cold weather are equally beneficial to those who engage in them. So is rowing—not for races but for exercise—in the early mornings and evenings, during the non-malarious seasons of the year. Practice with the dumb-bells, and moderate athletic exercises are also most useful. So is dancing in moderation, especially for young people.

Carriage exercise is largely indulged in by all classes who can afford it. It is a means of obtaining a thorough airing with a minimum of exertion. To the strong and healthy it should never be permitted to become a substitute for riding, walking, &c.; but in the case of the infirm, sickly, convalescents and others for whom more active exercise is contra-indicated, it is not to be regarded as a luxury, but as a necessity for the promotion or preservation of health.

TOBACCO SMOKING.

This habit is said, in moderation, to be pleasant and soothing. It is a luxury and quite unnecessary, and, in what is called excess, injurious. Fortunately, its prejudicial effects, unlike those of alcohol, are evanescent. It is the constant daily practice of excessive smoking, over a long series of years, that produces so much functional mischief and misery. It thus frequently disturbs the equilibrium of the nervous system and the action of the heart, causing nervousness, giddiness, muscular tremor, and palpitation; it impairs digestion, depresses the system mentally and physically, and muddles the intellectual faculties. Cancer of lip and tongue and chronic inflammation of the back and sides of the throat are often ascribed to it, as cancer of the æsophagus and stomach have been attributed to chewing and snuffing. We would counsel those who have acquired the habit and decline to relinquish it, to smoke the mildest tobacco—as seldom as possible—only after eating, and never in the morning, or not till after lunch; or, what is still better, not till after the evening repast.

Among the Hindoos the hookah is in universal demand. By means of this, the smoke is drawn through water, and thus—it is believed—is deprived of some of its more deleterious and poisonous properties. In former days it was largely employed by Anglo-Indians, but is now almost completely discontinued. Pipe smoking is not much in vogue, being considered too "trying to the nerves." The mild manilla cheeroot or cigar is generally smoked in the Bengal Presidency; in Bombay and Madras, Trichinopolis, Dindiguls, and in Burmah, what are called "Burmahs" are mainly consumed by Anglo-Indian smokers.

HYGIENIC AND SANITARY DIVISIONS.

For the purposes of this article, the Indian Empire may be divided into four regions, the leading meteorological characteristics of which are set forth in the subjoined tabular statement.

	Stations.	Latitude North.	Longitude East.	Elevation in feet above mean sea-level.	Mean Daily Temperature.	Mean Daily Range.	Mean Absolute Range.	Rainfall.
1.	Murree	33° 40′	73° 8′	7,507	55·9	15·2	63·7	42·26
	Simla	31 6	72 12	6,952	54·7	19·4	62·8	71·03
	Chakrata	30 40	77 55	7,051	56·1	15·2	57·3	72·36
	Mussooree	30 27	78 7	6,881	—	—	—	102·10
	Ranikhet	29 38	79 29	6,068	60·3	13·3	55·9	56·19
	Darjeeling	27 3	88 18	6,912	55·6	14·3	44·4	160·92
	Wellington	10 22	76 50	6,200	—	—	—	45·01
	Ootacamund	11 25	76 43	7,252	58	18	—	44·8
	Newera Eliya	7 0	80 42	6,150	66·8	15·9	42	93·01
2.	Pachmari	22 28	78 28	3,504	67·5	18·6	66·2	73·46
	Chikalda	21 24	77 22	3,656	69·9	—	52·6	77·33
	Mount Abu	24 36	72 45	3,945	67·1	14·6	54·2	71·52
3.	Thull	33 22	70 33	2,250	—	—	—	—
	Rawul Pindee	33 4	73 5	1,652	68·9	29·1	89·1	33·82
	Dehra	30 20	78 8	2,232	70·7	20·9	69·8	108·74
	Hazaribagh	24 0	85 24	2,010	—	—	—	44·35
	Seoni	20 6	79 6	2,030	74·1	23·5	73·0	52·90
	Buldana	20 34	76 14	2,131	75·5	17·4	56·7	42·91
	Poona	18 28	74 10	2,000	—	—	—	27·11
	Belgaum	15 52	74 42	2,550	73·7	20·7	58·4	54·31
	Bangalore	12 59	77 38	2,981	72·3	20·1	52·9	40·67
	Kandy	70 18	80 35	1,650	76·1	5·7	17·6	95·37
4.	Peshawur	33 2	71 37	1,110	69·3	28·8	92·4	5·84
	Lahore	31 34	74 20	73	75·1	27·9	87·8	19·8
	Dehli	28 40	77 16	717	77·0	22·3	77·9	35·95
	Agra	27 10	78 5	555	78·5	22·8	77·8	29·60
	Allahabad	25 26	81 52	306	77·6	23·7	78·6	42·35
	Lucknow	26 50	81 0	369	78·1	24·5	77·9	38·32
	Sibsagur	26 59	94 40	333	73·1	17·7	56·5	106·14
	Goalpara	26 11	90 40	386	75·0	15·8	54·8	109·63
	Calcutta	22 32	88 19	21	76·7	16·1	57·8	43·51
	Dacca	23 43	90 27	35	78·6	16·3	57·8	74·80
	Jubbulpore	23 9	79 59	1,351	75·3	24·8	78·2	50·27
	Saugor	23 49	78 48	1,807	75·8	23·4	66·3	39·33
	Akola	20 42	77 4	930	78·5	—	75·3	25·90
	Ajmeer	28 26	74 37	1,632	77·1	29·1	88·1	27·60
	Kurrachee	24 47	67 4	49	77·4	18·6	71·9	1·92
	Bombay	18 54	72 49	37	78·9	10·5	33·2	73·41
	Trichinopoly	10 50	78 44	274	81·7	21·0	48·1	26·34
	Madras	13 4	80 14	22	82·3	15·9	46·1	54·25
	Rangoon	16 46	96 12	40	79·5	—	—	113·69
	Colombo	6 56	79 50	40	81·3	10·3	21·7	84·32
	Galle	6 1	80 12	40	80·1	6·3	17·6	102·26

Thus, in the *first division*, is embraced a series of hill sanitaria, in many respects equal to the healthiest regions of Europe and similar climates. They are all temperate, genial, and, as is believed, free from the generation of malaria. Provided ordinary precautions are taken for the protection of the head against the direct action of the sun during the summer months, out-door exercise can be enjoyed, at appropriate periods of the day, throughout the year. Such forethought and provision are especially needful in the Nilgherries and at Newera Eliya. This will be apparent, if it be borne in mind that the former is only 11° 25′ and the latter 7° from the equator, and that their temperate character is entirely due to elevation, radiation, evaporation, mist, clouds, and a liberal rainfall. Even in the more northern sanitaria, it is not safe or advisable to go about, especially on southern or western aspects, in May and June, without substantial head-gear. The residence of the viceregal and local governments at these hill stations, during the rains and hot weather, has now become general with many departmental officers, who are thus enabled to escape the trying heat and malaria of their respective capitals and stations situated on the plains. At other sanitaria of equal salubrity, such as Kussowlie, Landour, &c., European troops and invalids are largely accommodated. Schools for the children of European soldiers and others have been founded on the Sub-Himalayas, at Simla, Sanawar, Darjeeling, and also on the Nilgherries and elsewhere, where the young people receive as good a moral, mental, and physical education as is practicable under the circumstances. They are robust, plump, healthy, and rosy.

These hill climates have long been used, as a refuge from the depressing heat and malaria of the plains, by all classes of Europeans who can manage to avail themselves of their great hygienic advantages, and by those whose constitutions have been weakened and reduced below par, by protracted occupation on the plains and by malarious disease. In the absence of organic lesions in important organs, such as the liver, alimentary canal, lungs, and heart, &c., the tendency to recurrence of the periodic forms of fever caused by malaria is lessened or prevented by a sufficiently-prolonged change to the hill sanitaria, whilst the whole system is remarkably reinvigorated. For such invalids and convalescents, they are invaluable, though not quite equal to the more radical relaxation and change of climate involved by two long sea voyages with a more or less protracted sojourn in this country, or in some of the other salubrious localities of Europe. When, however, there has been developed any marked structural disease of the cerebral, thoracic, or abdominal organs, or even when, without any discovered or discoverable mischief of this nature in these parts, the blood, the digestive and nervous systems have become seriously impaired or damaged, experience has shown that removal to Europe is absolutely necessary to check the further downward progress and to secure convalescence. For such cases, the hill climates are not suited. Moreover, it sometimes happens that invalids who have been weakened by heat and malarious fevers on the plains are liable to suffer from hill diarrhœa, especially at Simla, due probably to their previous enervated condition, diminution of air pressure, suppression of the action of the skin, bad water, and bad sanitation. Of late years, much attention has been devoted to the improvement of the conservancy and water supply at this and other sanitaria, with what effect in reducing the frequency of this flux we have no reliable information. In short, the sanitaria in the hills are conservative and preservative of health, and curative in many functional complaints of climatic origin; but they are distinctly contra-indicated in all cases of organic disorders of the prime viscera of the body; also in confirmed anæmia and dyspepsia, the result of prolonged malarious poisoning of the system.

The *second division* includes three hill stations, which, according to some recent authorities, are somewhat malarious in the autumn. It is said that the soil, richly charged with organic matter, and contained in basins hollowed out of the rocky basis of which these mountains are formed, becomes saturated with moisture during the rains, and that, after this season has passed, the only means of escape for the superfluous and stagnant fluid is by evaporation; so that we have here presented many of the supposed conditions which are regarded as productive of malaria—viz., an oozy surface, or damp subsoil, highly impregnated with organic matter in process of decomposition, or favouring the growth of germs (or, according to some, the bacillus malariæ), the drying-up period, and an adequately high temperature. There may also be swampy and stagnant grounds in neighbouring valleys, from which miasmata may be developed and swept upwards into the habitations at higher elevations. It has not yet, however, been satisfactorily ascertained whether the permanent population at the hill stations of this class, who never descend to the malaria-laden atmosphere of the plains, are actually liable to suffer from ague and spleen, and until this has been placed beyond doubt, the question of the local generation of the poison there must, for the present, be still viewed as an open one. Although these sanitaria are, in a great measure, preservative of health in those who have not been seriously enervated by ague, it has been noted that, in persons who have previously suffered from it, in any of its forms, recurrent attacks are by no means infrequent. They are warmer, less bracing, and less invigorating, than the sanitaria included in the first division; and, like these, they are not sufficiently beneficial in the organic effects and complications of intermittent fevers or serious lesions of the liver, spleen, bowels, lungs, heart, and brain.

In the *third division* will be found a series of stations at moderate heights above the level of the sea, standing, in respect of temperature and salubrity, between the *second* and *fourth* classes. Except in the autumn, the drying-up season, and the early part of the cold weather (when ague or intermittents are prevalent), they are tolerably healthy. The most salubrious are Dehra in the North-West Provinces, Hazaribagh in Bengal, Poona and Belgaum in Bombay, Bangalore in Madras, and Kandy in Ceylon.

The *fourth division* embraces the great bulk of British and feudal India. It is extremely hot in the summer, and very malarious in the autumn drying-up season and the beginning of winter. It includes the great deltas and valleys of the Indus, Ganges, Brahmaputra, Irrawadi, Nerbudda, Tapti, Godaveri, their numerous tributaries, and many other rivers; the plains or table-lands of Behar, North-West Provinces, Rajputana, Punjab, Scinde, Bombay, Deccan, Madras, and Ceylon; the Terais, or belts of oozy, swampy, and unreclaimed jungle and virgin forest lands, girdling the foot of the southern Himalayan spurs, the Vindhya and Satpoora, Nilgherry, Anamulli mountains, the eastern and western ghats, and other minor mountains.

The Hills.

As the sanitary and hygienic excellences of the hill climates of India are most important, we propose to give here a very brief and concise resumé of the peculiarities of each, including, as far as the data at our disposal will permit, their elevation above sea-level, air pressure, mean monthly and annual temperature, mean monthly, annual and absolute range of temperature, humidity and rainfall, and followed by such a summary statement of their utility in certain morbid conditions as the collective experience of medical practitioners in India would seem to justify.

1. *Murree*, 7,507 feet above the sea-level. Mean barometric pressure for the year 23°·850; highest monthly reading 23°·958 in November, lowest 23°·737 in July. Mean daily temperature for the year 55°·7: January is the coldest month with mean temperature of 36°·7; June is the hottest with a mean of 71°. Mean daily range for the year 14°·3, minimum in February 11°·1, maximum in October 17°·5; but in March, April, May, June, September, November, and December, it stands at 15°, 14°·6, 14°·1, 16°·7, 15°·5, 15°·4, and 15°·3 respectively. Absolute annual range 72°·7, minimum monthly absolute range 23°·6 in August, maximum 43°·9 in June. Rainfall 58·44 inches. The upper portion of the station is exposed to cold north winds, whilst the lower part is sheltered from all winds excepting those blowing from the west; measles, hooping cough, croup, pneumonia, and bronchitis are said to prevail among the children. On the whole, the climate is well suited for Europeans who are free from any organic disease of the prime organs.

2. *Simla* (6,952·74); meteorological record incomplete. Barometric pressure for the year 23°·41, varying from 23°·138 in July to 23°·363 in November. Mean annual daily temperature 34°·5: range wandering from 10°·8 in August to 20°·2 in November and 24°·1 in April. Absolute range for the year not given; but in April it was as much as 47°·7. Rainfall 70·20 inches. In May, June, July, August, and September, the fall amounted to 4·56, 7·90, 19·36, 18·17, and 6·27 inches. During these months the air is humid, and the station generally enveloped in clouds and fogs. It is then especially prejudicial to all who are predisposed to, or suffering from, pulmonary affections. Hill diarrhœa is common, particularly among delicate children and adults debilitated by the heat and malarial poisoning incidental to previous residence in unhealthy districts on the plains. Generally speaking, the climate proves beneficial to those who have been weakened by the operation of prolonged heat and overwork, by the merely functional effects of ague, whilst it is highly conservative of health in all, young and old, whose constitutions are radically sound and vigorous. It is believed to be free from the generation of malaria. But experience shows that it should be avoided by the phthisical, by those more than ordinarily liable to bowel complaints, and by those labouring under valvular affection of the heart, or serious organic disease of the liver.

3. *Chakrata* (7,051), founded in May, 1866, and occupied by European troops

in April, 1869, is situated in the Dehra Dun, North-west Provinces, on a range of hills overlooking the valley of the Jumna and the Torrs in the region known as the Jamsâr Báwar. Barometric pressure for the year 23°·227; lowest in July 23°·120, highest in November 23°·313. Mean daily temperature 55°·7; lowest monthly mean in January 39°·6, highest 70°·2 in June. Mean annual range 14°·3. During the wet months of July, August, and September, the range is 11°·4, 9°·6, and 11°·3. In February, March, April, May, June, October, November, and December, the mean daily range was 13°·8, 17°·4, 16°·1, 14°·9, 16°·1, 14°·3, 15°·3, and 17° respectively. Absolute range for the year 59°·7, lowest being 19°·4 in August. Rainfall 59·96 inches. Rain falls in every month of the year; but the bulk is registered in June, July, August, and September, measuring 7·03, 17·36, 15·18, and 5·89 inches respectively. The climate is bracing and invigorating, and promises to be a most valuable sanitarium for European troops.

4. *Mussoorie* (7,433). The greater part of the inhabited portion of the hill varies in elevation from 6,500 to 7,000 feet above the sea. We have no accurate record of the air pressure. As, however, the elevation is about 75 feet lower than Simla, the barometric pressure may be accepted as somewhat less than that given for that station. The lowest mean daily temperature was 42°·1 in January, the highest 74°·2 in June. The lowest mean daily range was 8°·5 in August, the highest 16°·3 in November. Absolute range varied from 18° in August to 38°·3 in April. The neighbouring station of Landour being 700 feet higher is more exposed, with a northerly aspect; is said to be about 4° cooler than Mussoorie. Rainfall 95·21 inches: 9·43, 29·68, 30·75, and 9·47 inches fell in June, July, August, and September. Rain falls in every month of the year. Persons suffering from the heat and malaria of the plains, and the consequent disturbance of the digestion, are benefited by a sojourn at both these sanitaria. There is little of the hill diarrhœa complained of at Simla. It has been said that phthisical patients are favourably influenced by residence on the southern aspect of the station. This opinion is probably based on a comparison of the behaviour of such cases in different parts of the sanitarium itself. But we are not aware that this influence has ever been regarded as being so marked in this class of disease as to warrant deviation from the general practice of abstaining from recommending patients so afflicted to be sent there. Organic affections of the heart, lungs, liver, and bowels are aggravated by the climate of Mussoorie and Landour.

5. *Ranikhet* (6,068) is situated in the Kumaon District, North-west Provinces. It affords more level land for building purposes, and is easier of access than any of the other Himalayan sanitaria. Barometric pressure 24°·058. Mean annual temperature 60°·3; mean daily range 13°·5; absolute range 56°·6. Rainfall 47·63. It is admirably suited for all those functional derangements attributed to the chronic and acute phases of malarious poisoning. But it is not deemed to be of much real service in diseases of the pulmonary and circulatory systems.

6. *Nainee Tal* (6,409) is also situated in the Kumaon District, North-west Provinces, and is the summer head-quarters of the local government. Mean annual temperature 58°. In summer the heat seldom surpasses 80°. In winter frost and snow sometimes prevail. Temperature varies from 78° to 48° in May;

69° to 59° in June; 78° to 61° in July; 76° to 62° in August. Rainfall 81·10 inches. In the monsoon months, the climate is wet, damp, and relaxing; and in winter, snow storms and cold raw winds are frequent. Hill diarrhœa is less common than at Simla. Rheumatism, neuralgia, croup, bronchitis, and pneumonia prevail during the cold months. Like most of the other hill sanitaria of corresponding elevation, it is unsuited for liver and bowel complaints. Neither are cardiac or pulmonary affections in any way benefited.

7. *Almora* (5,494) is in the Kumaon District. Owing to want of shade and the usual postponement of the rains, the heat of summer is considerable. Highest monthly temperature is 88° in May, lowest 36° in January. Rainfall 38·05 inches. In winter frost and snow are common. The snow seldom remains long on the ground. In this season, neuralgia, rheumatism, and chest complaints are frequent, much diminished, however, during the summer and rainy season.

8. *Darjeeling* (6,912) is situated on one of the crescentic ridges of the Singelalah range in Sikkim, is in direct railway communication with Calcutta, and constitutes the summer residence of the government of Bengal. Barometric pressure 23°·373 for the year; lowest 23°·276 in July, highest 23°·473 in November. Mean daily temperature for the year 54°·6; lowest monthly mean 39°·2 in January, highest 63°·3 in June. Mean annual daily range 13°·8: it is 10°·6 in July and August, 10°·4 in September, 17°·2, 15°·7, 14°·2, 15°·8, 15°·3, and 16°·8 in March, April, May, October, November, and December respectively. Absolute range 53°, lowest being 17° in July, highest 35°·9 in March. Rainfall 118·24 inches. It has been known to amount to 150 inches. It is, perhaps, the most salubrious of all the Himalayan sanitaria, and much of this is due to the comparative equability of its climate. It also enjoys considerable immunity from wind and storms. It is wonderfully free from hill diarrhœa. Its healthiness is demonstrated by its benefical effects on children. Even very weakly children transported thither from the malarious plains soon become firm, plump, and rosy. In all functional ailments due to malaria, residence at Darjeeling, owing to its equability of temperature, and apparently in spite of its remarkable humidity during the rainy months, is extremely advantageous. But in those liable to, or suffering from, organic disease of the abdominal, pulmonary, and circulatory organs, it is not so beneficial, though more so than any of the other sanitaria referred to. Many persons find it useful in approaching Darjeeling to remain, for a short period, at the lower elevation of Kurseong (4,500), thus allowing the system to become somewhat gradually accommodated to the altered air-pressure and temperature.

9. *Cherrapoonjee* (4,588) is situated in the Khâsi Hills, Assam. Rainfall for the three years ending 1876 averaged 368·41 inches. Blandford gives the average for 22 years at 492·45 inches. It is reported that, in 1861, it amounted to 805 inches, of which 366 inches were registered in the single month of July. Thus, whilst the average fall of rain in London is 2 feet, and in India 1 to 6 feet, that of Cherrapoonjee varies from 43 to 67 feet, deep enough to submerge a two or three storied house. "Cherra," as the station is usually called, "stands on the first of a series of hill ranges that rise abruptly from the plains

of Bengal and catch the vapours of all the clouds that roll up from the sea" (W. W. Hunter). Hence, this enormous rainfall exceeding—so far as our existing knowledge extends—that of any other place in the known world. It is now deserted by Government officials, but is still the head-quarters of the Welsh Calvinistic mission, who, as we have personally observed, continue to do good work among the aboriginal tribes of the Khási Hills. Notwithstanding its great rainfall, it is not considered unhealthy for Europeans.

10. *Shillong* (4,900 to 6,000 or 6,400 feet) is also situated in the Khási Hills, and, besides being an important military sanitarium, is the summer head-quarters of the Chief Commissioner of Assam. Highest average monthly temperature is 81°. The climate is temperate—cold in winter and damp in the rainy season. Frost is noticed in January and December; but snow is seldom seen. When the station was founded, it contained many oozy, swampy, and boggy hollows, which, until drained, affected the salubrity of the place. Rainfall, 86·93 inches, although it is only 20 miles north of Cherra. Rain falls in every month of the year. In April, May, June, July, August, September, and October, it amounted to 3·54, 10·24, 16·49, 15·92, 14·38, 15·58, and 6·21 inches.

11. *Pachmari* (3,564) is situated on the Satpoora range, in the Central Provinces. Barometric pressure 26°·413. Mean annual temperature 70°·7; highest monthly mean 83°·1 in June, lowest 54°·7 in January. Mean daily range for the year 18°; lowest 7°·4 in August, highest 26°·4 in December: in January, February, March, April, May, and November, it was 20°·7, 21°·4, 25°·8, 21°·8, 21°·0, 21°·3. Absolute range for the year 71°·5; in March it was 55°·8, in December 44°·9. Rainfall 80·93 inches, of which 9·86, 30·99, 20·09, and 16 inches were registered in June, July, August, and September. Rain falls in every month of the year. Owing to position and its moderate altitude, clouds and mist do not hang so heavily over it during the monsoon as at most of the higher Himalayan sanitaria. The range is considerable, except during the rainy season, rendering it ineligible as a resort for persons suffering from phthisis, liver, bowel, and heart complaints. Neither has it answered the expectations of early observers in warding off recurrences of intermittent fever. It has, however, proved very beneficial, during the summer and rains, to the officials and others of the Central Provinces injuriously affected by the heat and malaria of the plains.

12. *Chikalda* (3,656) is situated in the Melghát Táluk, Ellichpur District, Behar. Air pressure 26°·426 in December. Mean annual temperature 72°. May is the hottest month, when the average is 81°·8. The minimum is 64°·4 in January. Mean annual range, 14°·6; lowest 7°·3 in August, highest 20°·3 in May. Absolute range for the year 54°; lowest 13°·4 in August, highest 44° in March. Rainfall 58·13 inches, of which 8·89, 15·12, 16·73, 11·17 and 3·73, inches were measured in June, July, August, September, and October. It is useful during the summer and rains to the hard-worked officials of the plains. Like Pachmari, its climate is conservative and preservative against, rather than curative of, the ailments engendered in the plains.

13. *Mount Aboo* (3,945) is situated on a detached portion of the Aravulli range, in the Serohi District, Rajputana. The barometric pressure is 25°·817 in

July, 26°·118 in December. Mean daily temperature for the year 69°. Minimum monthly average 54°·2 in January, maximum 77°·9 in May. The extreme summer heat is about 92°, sometimes as much as 98°. Mean daily range for the year 15°·4, minimum 6°·9 in August, maximum 20°·1 in January. In February, March, April, May, June, October, November, and December, the average monthly range is 16°·4, 18°·3, 17°·2, 16°·7, 16°·1, 15°, 18°·1, and 19°·1 respectively. Absolute range for the year 61°·9; monthly minimum 16°·2 in August, maximum 43°·9 in January. Rainfall 63·36 inches, of which 5·43, 20·63, 23·12, 8·47 inches were counted in June, July, August, and September: but rain falls in every month of the year. In the autumnal months, Mount Aboo is said to be malarious, which is believed to be due to the oozy soil in the depressions scooped out of the granite rocks, of which the mountain is mainly composed, being super-saturated during the monsoon with moisture, which can only escape—charged with malaria—by evaporation. In the wet and cold months bronchial complaints are common. So are relapses of intermittent fever. Almost all other maladies, excepting phthisis, liver, heart, and bowel complaints, are benefited.

14. *Mahableshwur* (4,500 to 4,700) is situated on the prolonged and tolerably level summit of a range of the Western Ghats, in lat. north 17° 58′, and long. east 73° 42′, and constitutes the summer head-quarters of the Bombay Government. Mean annual temperature 66°; maximum 89°, minimum 40°, with daily range 8°. Mean temperature during the rains 63°, with range of 3°. Rainfall—average of 24 years—253·24 inches, of which 45·52, 97·88, 68·86, and 31·48 inches were measured in June, July, August, and September. The cause of this annual deluge is the striking of the water-laden atmosphere of the south-west monsoon against the ghats and the consequent precipitation of its aqueous vapour in the form of rain. From March till the bursting of the monsoon in June, the climate is mild and genial, with warm days and cold nights. Then there is a complete exodus of the inhabitants to Poona. The season re-opens in October, when the mean temperature is 66°, with a range of 7°. In November it averages 62°, and in winter the greatest cold experienced is only expressed in slight morning hoar frosts, due to evaporation and nocturnal radiation. During the season, or at all periods excepting the rains, most of the effects of malarial disease and heat are materially ameliorated. But after the mists set in in May, in spite of the remarkable equableness of the temperature, it is regarded as prejudicial to persons suffering from phthisis, rheumatism, confirmed liver, bowel, and heart affections.

15. *Nilgherries*, the Queen of Indian Sanitaria, is situated between 11° 12′ and 11° 37′ north lat. and 76° 18′ and 77° 5′ east long., and extends 29 miles from north to south, and 51 miles from east to west. Average elevation about 6,500 feet: that of the Wynaad district now added to the Nilgherry Commissionership is about 3,000 feet. There are four sanitaria on the Nilgherry hills, viz., Ootacamund, Coonoor, Wellington, and Kotagiri.

a. Ootacamund. This sanitarium has an elevation of 7,000 feet. It is situated on the slopes and at the foot of Dodabetta (8,622), Church hill (7,429), Snowdon (8,299), and Club hill (8,030), and is divided by a serpentine lake about a mile-and-a-quarter long, which is surrounded by an excellent carriage road upwards of eight miles in length. Mean annual temperature 58°·69, about 1° below that of Nice. In the warmest months, the temperature rarely surpasses 75°, in the shade occasionally descending to 54°, with an average range of 9°. In December and January, frost and snow sometimes occur, and the range is 16°. Rainfall 44·8 inches. The main force of the monsoon is expended on the Khoondah mountains to the south-west, and here as much as 112 inches of rain have been recorded. The surrounding heights are for weeks prior to the bursting of the south-west monsoon enshrouded in mist and cloud, and the air is humid, raw, and depressing. At other seasons, during the winter and early months of summer, the atmosphere is comparatively dry and bracing; but, owing to rapid radiation, invalids have to clothe warmly to avoid the chill liable to follow the sudden depression of temperature at or near sunset.

b. Coonoor (6,500), 12 miles from Ootacamund, is situated in lat. north 11° 20′ and long. east 76° 50′, or at the south-east corner of the Nilgherry plateau. Mean annual temperature 64° : that of summer is 70°, descending to 60° at night. It is, therefore, warmer than Ootacamund. Rainfall 55 inches, due to the interception of the main weight of the monsoon first by the Khomdahs, and secondly by the higher mountains in the neighbourhood of Ooty. It is more equable, owing to its lower elevation, to its being sheltered by the Dodabetta range to the north, and to its being directly influenced (1) by the south-west monsoons from June to September, and (2) by the north-east monsoon from October till January or February.

c. Wellington (6,200), a military sanitarium, is situated on the Jackatalla plateau about a mile-and-a-half from Coonoor. Standing at a lower altitude, and even more sheltered than Coonoor, the climate is proportionately milder.

d. Kotagiri (6,500)—imperfectly developed, owing to its comparative inaccessibility from the plains—is situated on the north-east end of the Nilgherry hills, 9 miles from Coonoor, and 14 miles from Ootacamund. It comes under the direct influence of the north-east monsoon more than Coonoor. The result of both monsoons is the production of a rainfall of 50 inches. It is the most equable of all the Nilgherry sanitaria, and was held in high esteem as a health resort by the late Marquis of Dalhousie and his physician, Dr. Alexander Grant.

It will be apparent from the foregoing remarks that, in the Nilgherries, the invalid may exercise a choice of climate not possible, in anything approaching an equal degree, at any of the other sanitaria brought under notice in this brief résumé. He may select Coonoor for its mildness, warmth, equability, and scenery to prepare his constitution for the cooler and more bracing climate of Ootacamund; or, if his case indicate such necessity, he may remain there during his sojourn in the hills ; or to escape the south-west monsoon, its discomforts and disadvantages, he may find a pleasant and congenial refuge at Kotagiri, where its depressing influence is only experienced in a much mitigated degree. And when the north-east monsoon prevails at Kotagiri, from October to January, he may exchange residence there for Coonoor, where its force is only slightly experienced, or for Ootacamund, where it is not at all felt.

The general experience of the many able physicians who have practised at these sanitaria tends to the conclusion that, whilst they are, at suitable seasons, particularly during the winter and hot months, eminently restorative in cases of ill-health caused by the heat and malaria of the low country, exhaustion of nerve energy, indigestion, portal plethora, and malarial fever uncomplicated with visceral disease of a serious character, they are not advantageous to those afflicted with liver disorder, dysentery, phthisis, cardiac, and brain disease. To those of all ages already in possession of sound physical and mental health, the Nilgherries, whether for temporary or permanent residence, stand out conspicuously as the most salubrious of all the known mountain climates of India. The children of European parentage, who remain all the year round, during the period set apart for educational training, are remarkably robust and healthy.

16. *Newera Eliya.* The geographical position, geology, fauna, flora, and ethnology, not to mention history and religion, show that the beautiful and picturesque island of Ceylon may be considered as a portion—now physically detached or isolated by the strait of Manaar—of the Indian peninsula. A notice, therefore, of its chief sanitarium may be appropriately included in this brief survey of the medico-meteorological characteristics of the principal hill climates of India. Its height is 6,150 feet above the level of the ocean, and 7° north of the equator. Barometric pressure for the year 24°·069. It varies little throughout the year, the maximum being 24°·41 in July, minimum 24°·099 in March. Mean annual temperature 59°·3. The lowest mean monthly temperature is 57°·7 in December, highest 61°·2 in May. Frost is unknown. Mean daily range for the year 17°·2; lowest mean monthly range 10°·9 in September, highest 24°·9 in March. Absolute range 45°·5. Annual rainfall 99·45 inches.

Newera Eliya is constantly for days and weeks together under a canopy of clouds and fog. Except in January and February rain often falls in torrents in every month of the year. At all seasons, the humidity is considerable, and excessive during the prevalence of the south-west monsoon. It is, therefore, gloomy and depressing, has an evil reputation for cases of phthisis, hepatic and bowel affections, rheumatism, and diseases of the heart and brain. In persons permanently located there, it is said to be protective against malarial fever, probably because its potential cause may not be generated on the spot.

The Terai.

This is the belt of rich, oozy, swampy, and waste land intervening between the foot of the hills and the cultivated plains, varying in extent in different localities. It is covered with tropical forests, coarse grasses, and reeds, some of which are, at full growth, ten feet high or more, and infested with reptiles and wild beasts. Owing to its proximity to the hills, the fall of rain, during the monsoon, is liberal—streams, springs, and swamps abound; so that the soil and air retain their character for humidity during the whole of the cold season, or even up to the month of April or May. Under such circumstances, cryptogamic, algoid, confervoid, and parasitic vegetable, and the lower forms of animal life thrive in the greatest profusion. During the whole of this period, or about nine months of the year, it is the home of malaria, and of the paroxysmal diseases caused by malaria, from ordinary ague to the most pernicious and deadly forms of remittent, often styled jungle, fever. Both the air and water are then believed to be charged with malaria. Hence the danger to the European who may visit the terai at this period—great during the rains, greatest during the autumn and winter, especially at night. Sleeping in it is, therefore, to be scrupulously avoided. Transit through it to the hills is speedily accomplished in the daytime. In March, April, May, and June, when it has been subjected to the desiccating influence of a tropical sun, it loses its unhealthiness to a great extent; and it is then that the sportsman can enter it in pursuit of large game with considerable impunity, and freedom from the risk of catching malarious fever.

The foregoing observations have special reference to the wild and unreclaimed portions of the terai. Where the jungle has been cleared, and the land brought under cultivation, its salubrity is much improved. The process of reclamation, and the two or three succeeding years, are inimical to health; but after this difficulty has been surmounted, the climate and ailments become analogous to those of the plains adjoining. Thus have sprung up, of late years, many thriving villages and tea plantations on lands which were formerly deadly jungle and swamps, the haunts of the python, the tiger, leopard, panther, elephant, and other wild animals. The European pioneers of tea planting in the Darjeeling and Bhootan terai suffered severely; many perished from malarious fever and its sequelæ, and from the non-observance of approved dietetic, hygienic, and sanitary principles. But now that ever-increasing areas are being denuded of forest, of rank and impenetrable jungle, and reduced to a state of good husbandry and cultivation; that the evils of intemperance in eating and drinking are better understood, and avoided accordingly; that drinking water is purified by boiling and filtration; that sleeping accommodation is provided in rooms well raised above the ground—in the most elevated portion of the estate—sometimes on adjoining spurs, at a considerable height; that the dry, or dry-earth system of conservancy is enforced; that the head and spine are thoroughly protected from the direct action of the sun; that cold tea is used as a beverage, instead of weak brandy and water, to allay thirst; that iced water only, or diluted claret takes the place of beer, &c., at dinner; that woollen under-clothing is worn at all seasons; and that prophylactic doses of quinine are often employed during the malarious months, tea planting, if not quite so healthy as occupations in other localities on the plains, is nevertheless profitably carried on by Europeans on terai land where only a few years ago, under the old conditions of jungle, forest, swamp and waste, their lives could scarcely have been sustained throughout a single cycle of the seasons, and would not have been worth more than one year's purchase.

INFLUENCE OF SUN AND HEAT.

After the European disembarks at any of the Indian ports, the first enemy confronting him at every turn by day is the sun. Not only are the direct rays prejudicial by virtue of their power and intensity, during the summer and rains, but the indirect effects are also apparent in the radiation of heat at night from over-heated rocks, sand, soil, and habitations. The native, who can live, thrive, labour, and toil under a sun which would soon prove fatal to his Aryan brother from the West, always shields the head by means of a puggree of cotton or muslin fabric folded round it in such a manner as to cover the top, a portion of the forehead, occiput, and temples, with a stout padding several inches in thickness; and sometimes, as in Scinde, Madras, Rajputana and other provinces, it is encircled by a wide-spreading margin, to shade the eyes, temples, and back part of the neck. The hair is also kept short, often periodically shaved—a custom which no doubt contributes to coolness and cleanliness, and, to some extent, compensates for want of ventilation in the close adjustment of the puggree. There is no space between it and the scalp, or in communication with the outer air for free ventilation. But we may infer from the porous nature of its texture, that the fluids of the perspiration are absorbed as rapidly as they are secreted, gradually passed upwards and outwards to the outer air by slow evaporation. The better classes also use umbrellas, made of palm or other leaves, or ordinary ones covered with white cotton sheeting. For the European, nothing is better than a solah or pith topee, either helmet-shaped or provided with a large and wide margin, to protect the eyes, temples, and back of the neck. It is a non-conductor of heat, very light, and easy to wear. Ventilating openings are made at the summit or sides, under the rim, in such a manner as to preclude the direct access of the sun's rays. Its usefulness and efficiency are increased by means of a light puggree bound round it at the junction of the body with the rim of the hat, leaving a strip of six or eight inches, suspended loosely over the back portion of the neck. Helmets made of felt, with ventilating apertures at the top or sides, or both, and rims to protect eyes, temples, and neck, with or without puggrees, are much employed; but they are mostly heavy to wear, and none are, in our opinion, superior to pith helmets or solah topees, which are efficient, light, cheap, and procurable in almost all the more important towns of India. Some fresh green leaves, or a light moistened pad inside the hat, and wetting the puggree or even the hair, will often be found to add to the protection against the heat and sun. It is well also to have an umbrella, which should be covered with white calico, to make it more impervious to the sun's rays.

MALARIA.

This is the greatest enemy which the European has to encounter in India. Whether the potential agent is a bacillus, a bacteria, a germ or a poison of a chemical nature, we shall not stop to inquire. For our present purpose, we shall employ the old term, and speak of malaria as the cause of more misery than almost all the other diseases included in our tropical nosology. The sun's rays, the heat, and other ills pale into comparative insignificance before its incessant operations against the health and lives of human beings in tropical and tropoidal regions, and of the higher animals essential to the welfare and happiness of man. No one knows what it *is*, but most people soon find out in their own persons what it *does.* No part of the plains or of the less elevated sanitaria is quite exempt from it, though some places are worse than others. Heat, moisture, vegetable matter and its putrefactive changes, certain soils, or geological formations, seem to determine the thing, or the condition, whichever it is, that causes ague, or remittent fever. The miasm is most pernicious in the neighbourhood of marshes, swamps, sub-montane belts of forest or low jungle, such as the terai, lying at the foot of the southern Himalayan spurs and other mountains in various regions of India; in the oozy, jungly, and saline marshes of the Sunderbuns, south of Calcutta, all of which are deadly during the sickly autumn and drying-up season. On the other hand, dry and arid tracts, such as the confines of the great deserts of Jodhpore and Bikanir, where the fall of rain is trivial or absent, and there are no swamps and marshes, as we observe them elsewhere, and superficial moisture is invisible, are not exempted from the diseases ascribed to it; but there may be local areas of undiscovered subsoil damp sufficiently heated to lead to its generation. For we know that there is no more fertile source of malarial disease than that which is found in subsoil water charged with organic matter, and rendered stagnant and putrid for want of efficient drainage. Hence the marked improvement in the salubrity of malarious districts by drainage and cultivation.

The first clearance of jungle, or turning up of ground involving the disturbance of rich virgin soil is invariably followed by the prevalence of the most pernicious malarious fevers. This has been over and over again exemplified in the reclamation of jungle and forest lands for the cultivation of tea and coffee in the Nepaul, Darjeeling, and Bhootan terai, in Assam, Cachar, the Wynaad, and Ceylon. We have had lately a most instructive example of the evil consequences of defective drainage, imperfect distribution or undue retention and stagnation of subsoil water, in the destructive fever that has been for years depopulating the villages of the Burdwan district in Bengal.

Malarial miasmata are influenced by the direction of the prevailing wind. Thus, the inhabitants on the leeward side of a swamp or marsh are more likely to suffer from ague or remittents than those residing on the windward aspect of it. It is said that a belt of trees—and particularly the *Eucalyptus*, or Australian gum-tree, from its rapid growth, where it can be got to grow—will protect to a certain extent, and that a covering of gauze, such as a mosquito curtain, will guard the sleeper at night. Malaria is more potent near the ground, especially after the sun has disappeared below the horizon. Hence the recognised value of an upper storey for bedrooms. This observation has been widely acted upon in the construction of the barracks for the European soldiers in all parts of India, and of the residences of tea-planters in the terai, with favourable results in the prevention of disease and the conservation of health.

Some Europeans much exposed to malaria would appear to become, to some degree, inured to it, or perhaps, what is nearer the truth, they learn by care and experience better how to avoid or mitigate its consequences. But it should be recollected that its pronounced expression in the form of ague or remittent fever is not by any means the only mode in which its presence may be declared. Broken health, anæmia, cachexia, enlarged spleen, neuralgia, rheumatism, and other ailments are frequent results, and it often happens that persons may be driven away by ill health due to malarial poisoning, without their ever having suffered from intermittent or paroxysmal fever, to suffer from paroxysms after leaving the place where they had long resided. The fever caused by malaria is known as ague, or intermittent fever, because it returns at intervals in a paroxysmal form with a cold, hot, and sweating stage. According to the intervals at which these recur, it is called quotidian, tertian, quartan, or it may return at irregular and longer intervals. When a concentrated dose of the poison has entered the system the fever may be continuous, but there are daily abatements of it; hence in this form it is called remittent. When still more severe it assumes almost the appearance of typhus, and is then most dangerous and fatal.

The primary affections caused by malaria are, therefore, numerous and grave. But in tropical countries it also predisposes to the invasion of other serious diseases, such as anæmia, hill diarrhœa, dysentery, congestive, inflammatory, and suppurative affections of the liver, portal plethora, hæmorrhoids, splenic enlargement, and many painful nervous ailments. Hence the vital importance of prevention. We take it that the time is far distant when this poison, which is so fatal to European enterprise and colonisation, can be said to be a thing of the past in tropical countries. Reclamation, cultivation, and subsoil drainage have done much in some places, and as these are extended, it will become more and more modified. Meanwhile, those precautions which are believed to mitigate or prevent its operation should be adopted. We recommend persons compelled to reside in unhealthy districts to spend, if they can, as much of the rainy season as possible and the whole of the sickly and drying-up season at any of the non-malarious climates on the hills. This may sometimes be varied by a sea voyage to the Straits, China, Ceylon, or by a journey, during the unhealthy months, to Europe. If obliged to continue at their posts in any of the innumerable homes of malaria, they should invariably have sleeping rooms in an upper storey. These should be large, provided with glass windows to shut out night currents in the malarious season, and the punkah used to promote sound sleep. Diet should be generous, drink sparingly and temperately utilised, and exercise taken in the early morning preceded by drinking a cup of chocolate, coffee, or tea. Protection from the sun should be adequate, and the vicinity of marshes and swamps avoided, especially after sunset. Drinking water should be boiled and filtered. Trifling derangements, constipation, diarrhœa, or feverishness should be corrected. A couple of grains of quinine, taken in the form of pill or powder, night and morning, is reckoned by many a safe and efficient prophylactic. But however successful the prevention of the paroxysmal fevers occasioned by malaria may have been, the insidious action of the poison, operating in conjunction with the heat of the climate, sooner or later undermines the health, and resort to Europe becomes essentially necessary for its restoration. The most experienced observers consider that such a change is desirable about every five, six, or seven years.

THE SEASONS.

There are three distinct seasons in India—the cold, the hot, and the rainy. Speaking approximately, the *cold* extends from November to March, the *hot* from March to June or July, and the *rainy* from that to October or November. They do not pass abruptly into each other; between each there is a transitional period. In Bengal they conform pretty closely to the description here given. In Madras the hot weather lasts longer, whilst the cold season is not nearly so pronounced. The seasons are greatly influenced in their course and regularity by the monsoons. The south-west monsoon commences with storms of thunder, rain, and winds; surcharged with vapour on the Malabar coast in May, reaching regions farther north later on. The Carnatic and Coromandel coast, being sheltered by the western ghats, are then exempt. It reaches Bombay at the end of May or beginning of June, Bengal about the middle, and Delhi at the end of June in diminished force and volume. In the Punjab, in the vicinity of the hills, the rainfall increases; but in the southern Punjab and the great desert region there is little rain. To the west, the vast alluvial tracts of the Indus and its tributaries, the saline swamps of Cutch, the rocky, rolling, sandy deserts of Jáisulmir and Bikaneer, are perennially dry, parched, hot, and nearly rainless. Thus there are great belts or tracts of country, commencing in Scinde and the north-west, with an annual fall of rain not exceeding a couple of inches. On the other hand, at Cherrapoonjee, to the east of the Himalayan crescent, 492·45 to 805 inches (1861) have been measured. Next to this, the greatest fall occurs on the western coast at Mahabaleshwur, where it averages 253 inches. In Tenasserim, towards the east of the Bay of Bengal, it reaches fifteen feet, or 180 inches. The east sea-coast line, with a considerable portion of the inland country, is cooled and fertilised by the moisture-charged breezes of the north-east monsoon, which prevails from the month of October to January, and which brings rain to the east coast south of Orissa. The amount of humidity varies greatly. The flat, low, rocky, arid, and sandy deserts and plains of Scinde, Bikaneer and Jáisulmir, have a very dry air, and extremely so during the hot months. At the same season the elevated table-lands of the Deccan and Central India, and the dusty and sandy plains of the North-west provinces have also a dry atmosphere, being heated by the country over which it has recently passed. The wind, during May and June, blows in these localities with the parching keenness and fierceness of a furnace-blast. On the other hand, the retentive soils of the deltas, of the great rivers, the adjacent low mountain ranges, all the districts west of the western ghats, and many on the east coast have an exceedingly damp climate.

In Bengal, the *cold* season commences about the middle of October, or beginning of November. The days are hot, but the mornings and evenings are cool. The wind is northerly; the air feels, by comparison, dry and bracing; the sky is bright, though there may still be cloudy days and occasional showers—the last traces of the monsoon. In November and December the weather is cooler, the north-east wind is fresh and sharp, and the air dry; there are heavy dews at night, dense fogs are apt to prevail, the thermometer ranging from 56° to 78°. About Christmas a few showers occasionally fall. January is colder; the air is bright and keen; fogs are frequent. One may be out all day in the open air, but it is always necessary to protect the head against the sun's rays. The thermometer falls to 46°, or lower, and rises to 75° or 76°. Until the middle of February the weather is delightful, but it then begins to get warm at mid-day. During these months the climate is most agreeable, and those who have been in camp declare that nowhere is there a more healthful and enjoyable season. It is strengthening to the system previously exhausted by the hot and rainy seasons. The appetite and strength return, and the frame becomes reinvigorated and elastic; but owing to abatement of the action of the skin, and great diurnal variation of the temperature, there is risk of visceral congestion, thoracic complaints, bronchitis, &c.

In March the *hot* weather sets in. The sun is increasingly powerful, but the nights are still cool. Atmospheric disturbances, called north-westers with heavy showers, now cool and freshen the air, and are sometimes accompanied by thunder and hail. The thermometer ranges from 70° to 85°, or higher. In April and May the weather becomes intensely hot, but there are occasional showers and storms that relieve the oppressive state of the air, which is generally hot and so damp as to prevent evaporation. The skin becomes clammy with perspiration, and irritable from the irruption of prickly heat. The thermometer ranges from 80° to 90°, or higher. The weather is intolerably oppressive, and at nights so close that it is difficult to sleep. The constitution becomes excitable, the nervous system depressed; weakly persons, and especially those who are of intemperate or irregular habits, suffer severely, and not unfrequently succumb to heat apoplexy or asphyxia. There is a tendency to fevers and liver complaints. In February and March cholera is apt to appear in Calcutta, and what has been termed the endemic area of Bengal, where—perhaps never quite extinct—its visitations are then most severe.

The *rainy* season, generally preceded by the lesser rains or "chota bursat" at the end of May and by intensely muggy hot weather, sets in from the south-west from the 20th to the end of June, accompanied by thunderstorms and showers, settling down into heavy "tropical" rain, which bring the much-longed-for relief, cool the air, and clothe the earth with verdure. This continues until October, when the rain abates, the winds become variable, and during September it usually ceases, though sometimes extending well into October or longer; the air is damp and oppressive during this transitional period; nocturnal radiation excessive, the thermometric range materially increased; and it is, at this season, that the European constitution suffers most—overtaxed by previous heat and damp, it is more than ever oppressed by the hot steamy atmosphere in this unhealthy season, when malarious diseases, hepatitis, dysentery, fever, spleen, boils, and other torments are apt to occur. During the drying up of the moisture, from about the middle of September to the end of October, malaria, or the efficient cause of intermittent and remittent fevers, is evolved and active; the vital powers are low, and the constitution readily affected by it.

In the North-west and Punjab, the above sequence is observed, but modified by latitude and the physical characters of the country. The *winter* begins earlier, is colder, and prolonged into spring. The air is dry and bracing, and life in camp or in the open pleasant and exhilarating. Still, the sun is sufficiently powerful to necessitate substantial protection to the head. The *hot* season is shortened by the encroachment of a longer winter, but the scorching heat of May and June, when winds blow as if they issued from a furnace, is so intense that the thermometer will rise to 110° or higher in the shade, and were it not for the cooling effect of perspiration and the material reduction of the temperature by means of punkahs tatties, and thermantidotes, European life would often be in great jeopardy. Indeed, natives as well as Europeans often succumb to the Loo-marna (hot wind stroke), as it is called in Hindustani. Barring this direct action of intensely heated wind it is not unhealthy, and with care a high state of health may be preserved. The *rainy* season is somewhat postponed, usually commencing in the early part of July, cooling the air, and ceases about the middle of September. Soon after this, the mornings and evenings become cool, with steamy, hot, and oppressive days, until the completion of the drying-up process, reaching far into the month of October. It is at this transitional period, gliding on to November, during which period there is remarkable variation between the temperature of the night and day, that malaria is generated in abundance, and the fevers produced by it abound in persons whose systems have been lowered in tone by the enervating influences of the preceding hot weather and rains.

In Southern India, the climate is modified by latitude and peculiar physical conformation. The sea-coast below the western ghats is hot, damp, and steamy; the elevated plateaux to the east of these ghats much drier. The Carnatic and Coromandel coasts are hot and dry, being uninfluenced by the vapours of the south-west monsoon. Here, and over a greater part of the country inland, there are really only two seasons, the *hot* and the *cool.* The north-east monsoon, which prevails from October to January, helps to cool the air in these months; but the delightful cold weather in Bengal and Behar, Central and North-western India is altogether unknown there. The thermometer at Madras ranges from 72° to 92° or higher. The ordinary diseases peculiar to the tropics prevail, and liver disease is nearly twice as frequent as in other parts of India. One great compensation is its daily sea-breeze; another is its accessibility by railway to the queen of Indian sanitaria, the extensive and beautifully undulating plateau of the Nilgherries.

Bombay is a hot steamy place, built on a muddy, marshy, and unhealthy site; but, like Calcutta, it has been much improved by sanitary works, and the provision of a wholesome water supply; and, like Madras, it has the advantage of the ozone-laden breeze from the ocean. It is only a few hours' rail from the romantic and picturesque sanitarium of Matheran—purified and sweetened by the direct operation of the sea-breeze—and a few more from Lanowli and Poona, a day's journey from which by horse dawk will land the invalid at the hot and cold weather health-resort—Mahableshwur.

PRICKLY HEAT OR LICHEN TROPICUS.

In May and June, but more particularly during the transition of the latter month into the rainy season, when the air is charged with excess of aqueous vapour, and the heat and electric tension greatly intensified; during those periods of the day, in the monsoon, when the clouds are scanty and the sun all the more powerful; as also during the steamy, oppressive weeks intervening between the end of the wet months and the beginning of the winter, the cutaneous irritability accompanying this affection is often most distressing. All new-comers are subjected to it; but it occurs in its most aggravated form in sanguineous temperaments. It is probably caused by an undue accumulation of heat first over-stimulating and exhausting the vaso-motor centres, resulting in dilatation, congestion of the arterioles of the sweat glands, and, in extreme cases, terminating in local extravasations, or even cutaneous furuncles. So long as the determination of the circulation to the surface is consistent with free secretion of the perspiration, or effective exalted function of the sweat glands, the condition relieves the system of much heat that, if undischarged in this manner, would induce mischief in the abdominal viscera predisposed to diseased action. To this extent the popular belief in the salutary influence of prickly heat is probably well founded; but when a considerable portion of the cutaneous arterioles become so turgid and engorged as to interfere with the functional activity of the sweat glands, there is danger lest this failure on a large scale may lead to undue concentration of heat within, and serious lesions of the central nervous ganglia, liver, or intestinal glands. In such cases the surface is liable to be rough and dry with considerable local extravasations.

The symptoms are irritation, uneasiness, prickling, tingling, stinging, itching, formication, redness, efflorescence, and roughening of the parts affected. In some cases there are local excoriations and sores from scratching, or small intensely painful cutaneous furuncles.

The *treatment* consists of regular exercise; full occupation; scrupulously careful regulation of the bowels; abstinence and temperance in eating and drinking; all the measures which we have recommended elsewhere for keeping the body cool; the tepid bath, to which may be added, in very intractable cases, enough carbonate of soda to make it slightly alkaline; and the use of soft-soap. The lightest flannel, or silk, should be worn next the skin, to maintain an even temperature, to absorb perspiration, and guard against the external heat. Seeing that the condition is due to a cause operating from within, we place more reliance upon general than merely local management; but when sores, excoriations, furuncles, or small boils result, these must be dealt with locally as well as on general surgical principles.

FEBRICULA.

Few persons pass a year in India without suffering from fever. There is febricula, that lasts for a few days and passes away, perhaps never to return, without doing much harm. Its leading *symptoms* are malaise, disordered secretions, headache, muscular aching, weakness, loss of appetite. It may be caused by the influence of heat on a constitution not inured to it, irregularities of diet, and, quite probably, by the mildest expression of malarial action. The treatment is simple—remain at home, take a dose of aperient medicine, cooling drinks, and a light diet, saline diaphoretics in the hot stage, a few grains of quinine after it has subsided. If it does not disappear in a few days, it will require other management.

AGUE.

Ague, or intermittent fever, the product of malaria, is known by its passing through three distinct phases. 1. The *cold* stage, ushered in by chilliness, shivering, roughness and blueness of skin. 2. The *hot* stage, with a dry hot skin, quick pulse, headache, and prostration. 3. The *sweating* stage, in which the paroxysm, as we call the whole attack, passes away amid profuse perspiration, leaving the patient, in the course of a few hours, with a feeling of renewed health. *Treatment.*—Plenty of warm blankets, warm bottles to the feet, warm drinks during the cold, diaphoretics during the hot, and a ten- or fifteen-grain dose of quinine during the sweating stage, and liquid food only. When the attack is over, the bowels must be regulated, and four- or five-grain doses of quinine given every four or six hours to prevent a return of the paroxysm, for it is one of the characters of this fever to return periodically, as a quotidian, tertian, or quartan, or at less regular, shorter, or longer intervals. But, in the main, rest in bed or in the house. The management above sketched is that which must be adopted also for recurrent attacks.

Enlargement of Spleen, Anæmia, &c.

Intermittent fever, when repeated season after season, or the insidious and prolonged operation of its efficient cause alone, without expression in actual fever, eventually undermines the strongest constitutions by producing splenic enlargement, portal and hepatic congestion, anæmia, cachexia, neuralgia, dyspepsia, and a host of other ills attributed to climate, but probably due to malarial poisoning. In enlarged spleen, with anæmia, three grains of quinine with two grains of sulphate of iron in water, two or three times a day for some weeks; keeping the bowels regular will be of benefit, but nothing more than this demands change of climate.

Remittent Fever.

Believed to be caused by a concentrated dose of malaria. Its intensity may be influenced also by the state of the system and locality. Be this, however, as it may, some authorities consider that not only is malarial fever rendered remittent in this way, but it may pass into a condition not easily distinguished from typhus. Such are the worst types of jungle fever. The treatment, at the beginning, is that of simple fever, and it is well to try ten-grain doses of quinine every four hours until singing in the ears is produced. But whenever a fever in India fails in a few days to intermit, and the symptoms are becoming more severe, skilled assistance must be solicited without delay.

Typhoid or Enteric Fever.

It is somewhat over thirty years since this serious disease was first recognised among Anglo-Indians, and about twenty-five years since it was detected among the natives. In both races it had doubtless been grouped with remittent fever, and had previously accounted for the greater part of the mortality under this heading in the older returns. As elsewhere, it chiefly prevails among young people under thirty years of age. In Europe and in India it may be due to specific contagion from water contaminated by organic matter, by drains, by sewers, or by cesspools; or, as has been recently contended by some experienced physicians belonging to the naval and military services, it may be a form of miasmatic and climatic disease, as observed in tropical latitudes. Experience has shown that it is most successfully prevented by scrupulous cleanliness, abundant flushing and ventilation of closets, drains, and sewers, with the isolation of the air of these sewers from the house-drains by effective traps; where this system does not exist (as in most Indian districts, towns, and stations), by the dry, or dry earth, system of conservancy; by boiling, filtration, and thorough purification of the water used for drinking purposes; by the utmost attention to the quality of milk and food, and to rules of general and personal hygiene; and by avoiding, as much as possible, undue exposure to the direct influence of the sun in the hot, rainy, and drying-up months, and to malaria, especially at night.

It usually comes on with feelings of chilliness—occasionally, during the malarious season, intensified into the character of genuine ague—languor, lassitude, general physical and nervous prostration, headache and feverishness, abating or remitting slightly in the morning, only to be aggravated towards noon, afternoon, evening, and the greater part of the night; there is quickened pulse, elevation of temperature, and loss of appetite, with or without nausea and vomiting. In a few days the temperature ranges from 102° to 103°, or later even to 104° or 106°, or more, with great thirst, a tongue covered with a brownish fur at the centre and base, but red at the tip and margins; wandering or delirium at nights; there is increased loss of appetite and prostration, and diarrhœa (not always), with pain and sense of distention or uneasiness over the lower part of the abdomen, towards the right side; and successive crops of rose-coloured spots appearing on the chest, abdomen, upper arms, thighs, and neck, disappearing on pressure, and returning on the removal of the same during the middle and end of the disease. It generally runs a course of about twenty-one days, and in bad cases it may be prolonged for six weeks or longer; or after convalescence has been promised by subsidence of the fever for some days, a relapse may be excited, and the course of the malady may be repeated in an aggravated form. Hæmorrhage from the bowels; intense pain, suddenly developed, and soon spreading all over the belly, accompanied with retching, vomiting, a very quick, thready, and failing pulse, and profuse, cold and clammy perspiration, or collapse; a persistent high temperature of 104°, or more, with little or no morning remission; and a pulse constantly over 130, with increasing feebleness, are most unfavourable indications.

The commencement and course of this, like most other fevers and many other diseases, in tropical climates, are materially modified and complicated, especially during the malarious months, by the influence of malaria. But, as has already been stated, whenever a fever, however mild at first, does not yield to rest, bland, farinaceous and animal soups and broths, and careful regulation of the bowels in a few days, no time should be lost in securing the aid of a physician. Pending his arrival, the bowels may be acted upon, *if necessary*, by a couple of drachms of castor oil with five drops of laudanum (but, as a rule, purgatives should be avoided), and the local pain of the lower portion of the abdomen alleviated by hot fomentations, or by the application of flannels, freely sprinkled with turpentine. If, however, diarrhœa has set in, and exceeds three motions a day, this must be controlled, rather than actually stopped, by a tablespoonful of chalk mixture, with thirty minims of tincture of catechu, and ten minims of laudanum, after each loose evacuation. It is well, also, to give five-grain doses of quinine three or four times a day. Absolute rest in bed, in a large, well-ventilated room, as much raised above the ground as possible, is essential. The body, body-linen, and bedding must be kept scrupulously clean. The food should consist of sago, rice, arrowroot, beef-tea, mutton broth, chicken broth, jellies, so varied in administration that the same kind must not, unless demanded by the patient, be given twice in immediate succession. Thirst to be quenched by iced toast or soda-water, or the latter with an equal quantity of the best cow's milk that can be commanded. The room and stools must be thoroughly disinfected with carbolic acid, or other disinfectant—the latter removed and buried deep under the soil at a distance. Last, but not least, the best skilled nursing available must be secured.

SUNSTROKE, HEATSTROKE, OR INSOLATION,

May be caused by the direct influence of the sun, or indirectly by the action of great heat. An atmosphere approaching the point of saturation with aqueous vapour, coupled with such heat and electric tension as is experienced, during the period of transition, from the hot weather into the beginning of the rains in Bengal, favours the invasion of the serious conditions characterising any of the forms of sunstroke. Under these circumstances, the cooling of the body by evaporation of the perspiration is impeded. Evolution of heat by radiation is also diminished ; and there is consequently too much heat accumulated within the body. It is not got rid of as quickly as it is produced. The first effect, in mild cases, is over stimulation of the cerebro-spinal nerve centres, passing, in severer cases, more or less quickly, according to the intensity of the causes and the condition of the individual, into shock; or, eventually, partial or complete paralysis of the centres presiding over the functions of the heart, lungs, vaso-motor system, and brain. Any of these dangerous results are more likely to happen in those who live generously and intemperately, especially at what is recognised as the sunstroke season just alluded to. Dry air promotes the escape or excretion of the animal heat by evaporation and radiation, so that a much higher temperature can be tolerated with impunity in such an atmosphere than in one saturated or highly charged with moisture.

1. When the shock or over-stimulation is concentrated on the cardiac centre of the medulla oblongata, the immediate danger is from failure of the power of the heart to carry on the circulation, or from a faint or syncope. There is general nerve and muscular exhaustion, a feeling of sinking at the pit of the stomach, and of oppression in the neighbourhood of the heart, prior to the supervention of the unconsciousness which eventually comes on in bad cases, but which is not noticed in those of less severity ; a weak and quick pulse, sometimes intermitting or irregular, ghastly pallor and coldness of the surface—symptoms resembling collapse from serious accidents.

Treatment.—Recovery is promoted by securing the removal of the patient to the shade, or to a cool and well-ventilated room. All excessive clothing should be taken off, and the cold water douche applied a few times in quick succession over the head and trunk, with a view to rouse the action of the heart, and to accelerate the flow of blood through the lungs and brain by the reflex effect thus produced. It is rather this reflex stimulation than the cooling effect of the douche which is aimed at; and care should be taken not to continue it too long at a time. In unskilled hands, the best stimulant by the mouth is cold tea and beef-tea. The recumbent position must be maintained. Moderate shampooing is useful; so are mustard sinapisms to the nape of the neck, pit of the stomach, and calves of the legs.

2. When the brunt of the shock is borne by the respiratory centre, we have, particularly in intemperate persons with damaged organs, imperfect oxidation of the blood, and what is known as heat asphyxia. "The symptoms of this form of insolation, the real *coup de soleil*, are those of sudden and violent injury to the nerve centres, unconsciousness and cold skin, feeble pulse, all the symptoms of depression, death resulting from rapid failure of the respiration and circulation. If not fatal, reaction may result in a variety of conditions indicative of the injury done to the cerebro-spinal system." (Fayrer, "Quain's *Dictionary*," p. 1559. 1882.)

Treatment.—This is similar to that advised for heat exhaustion, but the douche must be applied longer and more vigorously, partly to lower the temperature of the overheated nerve centres, and to rouse them to functional activity. If, on the establishment of reaction, the body heat rises with increased unconsciousness, we have seen good results follow immersion in a bath cooled with ice. But this is a measure requiring medical direction and supervision. Whenever there is evidence of constipation, ten grains of calomel should be placed on the base of the tongue, and cathartic enemata employed assiduously until the bowels are relieved.

3. When the chief stress of the heat shock falls upon the vaso-motor centres, those supervising and regulating the production of animal heat, and also in variable degrees upon the brain and other nerve centres, there is high fever, amounting to 106°, 110°, or higher, there is great excitement, delirium, convulsions, or coma, a full and labouring or an accelerated and jerking pulse, hurried and difficult breathing—symptoms which are often preceded by nervous restlessness, prostration, and great frequency in micturition.

Treatment.—In this form, termed *heat apoplexy* or *thermic fever*, the immediate aim is to reduce the temperature, to clear out the bowels, and to restore the functions of the parts injured. The main object is best accomplished by cold affusion, the ice-cap to the head, and immersion in a cold bath cooled by means of ice, or by an iced shower bath. By keeping the thermometer in the rectum, the reduction of body heat produced by these means may be accurately measured. Care should be taken to stop this treatment, when the normal temperature, about 98°·5, has been gained; but it will generally be necessary to keep on the ice-cap to the head. The bowels should be promptly acted upon. If we have regard to the great mortality, which takes place in a given number of cases of insolation, amounting as it does to 45 or 50 per cent., or to the unsatisfactory prospect of those who escape with life rather than with perfect recovery, the superlative importance of adopting those measures and precautions which we have recommended with a view to mitigate the effects of exposure to the direct rays of a tropical sun, and of the stifling heat within doors, especially during the sunstroke season, will be readily appreciated.

It has been ascertained that about 50 to 55 per cent. of cases of these three groups of insolation, regarded as a single class of disease, ultimately survive; but many distressing results often remain from the two last mentioned, viz., heat asphyxia and thermic fever, rendering the patient a source of suffering to himself and of anxiety to his friends, and ever after unfit to sustain exposure to a tropical sun or great heat. The imperfect nature of many of the recoveries, and the permanent injuries too often inflicted upon essentially important parts of the cerebro-spinal nervous system, give to the prevention of such a fatal malady a value not paralleled or exceeded by that in relation to very many other morbid conditions with which we are acquainted.

Effects of the Climate on Women and Children.

European *women* eventually suffer from insufficient exercise and occupation, the prolonged operation of heat, the enervating influence of malaria, and the affections caused by it. Those who are able to take regular horse and carriage exercise, and enter into the highly salutary open-air recreation of croquet, badminton, or lawn tennis, preserve their general health most successfully. Dancing in moderation, as has already been observed, with early hours, is also beneficial. Women not being called upon to undergo so much exposure, do not suffer, to the same extent, as men from the sun and malaria; but their greater confinement to the house, often in darkened rooms, and their sedentary lives, with the absence of any regular physical employment such as is both enjoyable and healthful in temperate climates, tend to produce laxity of fibre, impairment of digestion and assimilation, anæmia, and result, in a few years, in premature aging, attended by recession of the eyes, prominence of the cheeks, a certain amount of pinching of the features and loss of flesh generally ; or, in others, the degeneration assumes the form of obesity with pastiness, puffiness of the face, and more or less decided pallor. In both groups there is often sallowness, almost always the *facies miasmatica,* or malarial brownness of the skin, if they have been invaded by intermittent fever, or been subjected to slow and insidious poisoning by its efficient cause.

European *children* do not thrive so well, on the plains, as they do at home. This is in some part to be explained by the fact that, owing to the prejudicial influence of the climate and its diseases upon the mothers, a large proportion of them have to be reared by the mother's milk largely supplemented by the milk of the cow, by comparatively inefficient native wet-nurses, or by hand feeding with cow's milk alone. They suffer a good deal from teething, bowel affections, and, when hereditarily predisposed, from tubercular diseases. They seldom possess the muscular rotundity, hardness, plumpness, and rosy complexions of those of their kindred in colder regions. On the other hand, they enjoy a singular immunity from scarlatina, and when they do suffer from measles the attacks are mild, and seldom aggravated, to the same extent, as in England by capillary bronchitis. Hence, although most physicians must perceive that European children would be better at home, the necessities of parents, the exemption from some serious infantile complaints, and their fairly healthy condition have partially reconciled the parents and their medical advisers to sanction their temporary retention in India.

It has been noted that, at from the fourth to the sixth year of age, European children begin to shoot up too fast and disproportionately, become lean, lanky, and lethargic. Experience has always shown that it is now best, if it can be managed, to send them home for the double purpose of perfecting their physical and mental education. For those who cannot be so provided for, the healthiest hill climates may be selected; but though these are infinitely superior to the plains, neither the education nor the climate of the hills can be regarded, either hygienically or socially, as efficient substitutes for those of Europe. We hold, therefore, that the selection of the hills for the physical and intellectual training of European children should only be made on the ground of necessity, and not of choice.

Such being our views, very briefly expressed, on the best method of providing for the wants of European children in India, it will be readily understood why we deprecate the practice (still too prevalent) of transferring those born in England to that country. We are frequently solicited to make an exception, on the ground that the child will be taken to the hills; but as it is better, whenever it can be done, to provide for the rearing of the child at home, we feel constrained to withhold our sanction from such a request for all children above two years of age, indeed, for infants also, if it be possible to make any satisfactory arrangement for their being carefully reared at home.

POISONOUS SNAKES—SCORPIONS, CENTIPEDES, MOSQUITOS, LAND LEECHES, ETC.

It has been calculated that about 20,000 natives perish annually from the effective bites of snakes in India. Europeans, from the greater security they enjoy in the construction of their houses, and the special precautions they adopt when travelling abroad at night, are seldom bitten. The venomous snakes are the cobra, bungarus, ophiophagus, krait, Russell's viper, echis carinata, a few others comparatively rare, and most, if not all, the salt-water species. Their effective bites are most deadly. We give below a few simple rules by which poisonous, may be readily distinguished from innocent, snakes.

1. *Cobra* (*gokarrah, karris,* &c.) are all hooded, and, with but few exceptions, have spectacles, or an ocellus upon the back part of the neck. If dead, the skin will be found to be hanging loose on each side of the neck, and if slight traction be made upon it from both sides simultaneously, the spectacles or ocellus will be brought into view. Then, on opening the mouth, a prominent part will be found, on the front portion of the upper jaw, on each side, immediately before the eyes. If a piece of stick or a probe be pressed against these from behind forward, the fangs will be raised and brought into distinct relief. Every venomous snake possesses these fangs, whilst all the non-venomous snakes are destitute of them. The latter have a row of fish-like teeth. Cobras differ considerably in colour. Generally speaking, however, they are yellowish, grey, or black, the two first-mentioned kinds being usually found in old houses and rubbish, and the last variety in paddy or rice fields, or in the open country.

2. *Daboia Russelli—Russell's Viper* (*úlú bora, chandra bora, shia chandra,* &c.) is usually found about from three to four feet long. It has a well-pronounced triangular-shaped head, with a distinct neck. Superiorly, it is marked in black white-edged rings, the ground being either greyish or chocolate in colour. The

markings somewhat resemble the pattern of a cashmere shawl. It is the chain viper—the Tic Polonga of Ceylon. The tail is short and thin. The fangs are very large—much larger than those of the cobra.

3. *Bungarus Ceruleus* (*krait, dhomma chitti, chitti,* &c.) is generally met with about three feet long. It sometimes grows to the length of four feet. It is either steel black or brown, striped with white. It will at once be recognised by the colour and the single row of hexagonal scales running along the centre of the back. Its fangs are distinct. It is often confounded by the natives with the *Lycodon aulicus*, an innocent snake.

4. *Bungarus fasciatus* (*raj samp*) is easily recognised by its triangular-shaped body and very prominent back. It is alternately blue and yellow, and, like the krait, has a dorsal row of hexagonal scales. Its fangs are easily detected.

5. *Ophiophagus Elaps* (*Airaj of Orissa*) is of large size, hooded like the cobra, but not so much. This hood can be easily made out after death by using traction on the skin on each side of the neck. The fangs are easily discovered. It ranges in length from nine to twelve feet.

When a person is bitten by a poisonous snake, send at once for the doctor. Pending his arrival, apply a ligature, made of a piece of cord, round the limb or part at or about two or three inches above the bite. Introduce a piece of stick or other lever between the cord or part, and by twisting tighten the ligature to the utmost. Apply two or three ligatures above the first at intervals of four or six inches, and tighten them also. After the ligature has been applied, scarify by cutting across the puncture to the depth of a quarter of an inch, with a sharp penknife or other cutting instrument, and let the wounds bleed freely or, better still, excise the punctured and poisoned part. Apply either a hot iron or live coal to the bottom of these wounds as quickly as possible, or some carbolic or nitric acid. If the bite be not on a finger or toe, or on a part where the ligature can be applied, raise up the integument with the finger and thumb, and with a sharp penknife cut out a circular piece as big as a finger nail round each puncture, *i.e.*, round the points of the finger and thumb—to the depth of a quarter of an inch. Then apply the hot iron to the bottom of the wounds, and wash the part with solution of permanganate of potash. Give fifteen drops of liquor ammonia, diluted with water, immediately, and repeat it every quarter of an hour, for three or four doses or longer, if symptoms of poisoning appear; or give hot brandy or other spirit, with an equal quantity of water, about an ounce of each for an adult, at the same intervals. Should no symptoms of poisoning come on in half an hour, the ligatures should be relaxed, or the part will perish from gangrene. If depression, faintness, nausea, hurried respiration, and exhaustion supervene, the ligature should not be relaxed until the person is recovering, or until the ligatured part is cold and livid.

Another plan lately introduced by M. de Lacerda is not to scarify, excise, and cauterise, &c., but to inject into the site of the bite a one per cent. filtered solution of permanganate of potash, the object being to follow up and neutralise the poison. If, by this method, a sufficient quantity of the antidote could be accurately brought into contact with all the virus in the tissues (the mixture of snake poison and solution of permanganate of potash out of the body, when injected under the skin, is quite innocuous) it might prove an effectual remedy; and we are glad to observe that Mr. Richards is zealously prosecuting a series of experiments, with a view to determine the value of the practice.

Suction of the wounds may be beneficial, but as it may be dangerous to the operator, it cannot be enjoined as a duty. If, however, it be practised, rinse the mouth thoroughly, both before and after the procedure, with the permanganate of potash solution. If symptoms of poisoning set in and increase; if the patient become faint or depressed, unconscious, nauseated, or sick, apply mustard-poultices or liquid ammonia on a cloth over the stomach or heart; continue the stimulants, and keep him warm, but do not shut him up in a hot stifling room or small native hut; rather leave him in the fresh air. Do not make him walk about if depressed; nurse him with stimulants, mustard-poultices or ammonia, but let him rest. If the person be seen some time after the bite has been inflicted, and indications of poisoning are present, the same measures are to be resorted to, or the new method of M. de Lacerda may be adopted. They are less likely to be so successful at this late period of the case, but nothing else can be done.

In many cases the prostration is due to fear; the bite may have been that of a harmless or exhausted snake, and persons thus bitten will, of course, rapidly recover under the use of the above measures. If poisoned, but, as is frequently the case, not fatally, these measures are also the most expedient; if severely poisoned, no others are likely to be more efficacious. People should be warned against incantations, popular antidotes, and loss of time in seeking for skilled aid. The remedial means suggested are no doubt severe, and not such as under other circumstances should be entrusted to non-professional persons; but the alternative is so dreadful, that, even at the risk of unskilful treatment, it is better that the patient should have a chance of recovery.

The *land leeches*, so common in tea and coffee plantations, in many parts of India and Ceylon, particularly during the rainy season, are guarded against by wearing leech-proof boots and gaiters tightly fastened at the ankles and knees. But such is their agility and voracity that they often mount the shoulders, and thus gain access to the neck and wrists before being noticed, and such is, as we have personally experienced, the painlessness of their bites, that attention is generally attracted to their presence, not by any painful sensation, but by the feeling of blood trickling over the adjacent skin, or by the sight of it oozing through the socks or other apparel. The *bamboo Tick* met with in the sub-Himalayas buries part of its head, and anchors itself in the skin, remaining there, unless disturbed, until it becomes enormously distended with blood. If it be violently and prematurely detached, the head may be broken off and left behind, causing some amount of festering and suppuration. The application of very hot water and gentle traction are the best means to be adopted for its removal. *Bugs* are frequently met with in old furniture in imperfectly cleaned houses; and *fleas* abound, in some parts of India, in the hot weather. These irritating pests are best got rid of by absolute cleanliness, so constant and unremitting in its application daily as to give them no peace.

Most Anglo-Indians suffer much from *mosquito* bites. The consequent irritation may be lessened by cooling lead lotion, sal volatile, or eau de Cologne; and it is said that the application of camphor, penny royal, and lemon juice to the skin will keep them away. So, it is reported, will the smoke of the combustion of green wood, and the sprinkling of the room freely with carbolic acid. At night, protection is afforded by mosquito curtains. A mosquito room, sufficiently commodious for a bed and a writing table, similarly protected and furnished with a punkah inside, is often used in lower Bengal. During the hot and rainy seasons, a well-manned punkah suffices to keep these irritating insects at bay; but, in the cold season, when the punkah is not in request, the protection of good mosquito curtains becomes indispensably necessary to ensure sound refreshing sleep at night. In new comers and in other persons, who are, in what is termed a bad habit of body, the parts bitten by the mosquito not unfrequently fester or suppurate, and cause much temporary trouble.

Centipede and *scorpion* poisoning is sometimes observed. The pain, especially in that following the sting of the scorpion, is severe, and in unhealthy and weakly children, it might be dangerous; but a cooling lotion, or ipecacuanha and ammonia, applied externally, seems generally to neutralise the action of the poison and to appease the pain. We have never seen fatal results from poisoning by either of these insects.

CLIMATE AND HEALTH-RESORTS.

By Hermann Weber, M.D., F.R.C.P., Lond.

Physician to the German Hospital.

Causes of Climates—Constituents of Climate—Chemical Composition of the Air—Temperature—Humidity—Atmospheric Pressure—Light and Transparency—Electrical Conditions—Circulation of the Atmosphere—General Considerations—Division of Climates—Humid Marine Climates—Marine Climates with Mean Humidity—Winter Resorts on the British Coasts—British Summer Resorts—Dry Marine Climates—Inland Climates—Mountain Climates—Lowland or Plain Climates—Selection of Climates and Health-Resorts—Uses of the Home Climate.

The climate of a locality is the combined effect of the air by which it is surrounded, and the nature of the surface—solid as well as fluid—in their relation to animal and vegetable life.

Climate is composed of numerous more or less varying agents, the substratum of which is the atmosphere. The latter especially interests us, and we have to consider—first, its chemical composition, and the substances floating in it; secondly, the temperature and diathermancy; thirdly, the degree of humidity; fourthly, atmospheric pressure, or density; fifthly, light and transparency; sixthly, the electrical conditions; and, seventhly, the circulation of the air. We shall try to sketch separately the influence of these different points, but we must bear in mind that they are not separate in nature, but are intimately connected with, and constantly modified by, one another.

Causes of Climates.

The necessity of the difference of climate in the different parts of the earth is easily understood by the consideration that the sun, through heat and light emanating from it, is the main originator of the processes occurring on the surface of the earth and in its atmosphere. We know that the earth moves round the sun once in the course of the year, and revolves on its own axis once in twenty-four hours, and that on this depend the seasons, and day and night. If the earth were a round globe of an even and dry surface, it would be possible to calculate with some degree of certainty how much light and warmth each given point would receive during the whole year, and at every period of the year, even on every single day. The climate of the different parts of the earth would then be constant. This is the *mathematical* climate.

The earth is, however, not a smooth globe of equal composition in its different regions; one part of it is water, another is land, and the distribution of both varies considerably in different parts of the globe. The surface of the land is not level, but is made up of plains, mountains, and valleys; and, in addition to this, the nature of the surface varies, being in some places dry rock of lighter or darker colour; in others grass-land; in others forest or marshy ground, interspersed with inland lakes and rivers. Through these differences in the nature of the globe's surface, the calculated climates of different parts are considerably modified, and the actual changeable climates thus produced we call *physical* climates.

The main agents determining the character of the climate of a locality are—first, the distance from the equator; secondly, the elevation above the sea; thirdly, the relation of its position to adjacent seas, or large inland lakes, or hot deserts, or arctic regions; fourthly, the predominating winds; fifthly, the nature and configuration of the surface, including aspect, shelter, slope of surface, colour of soil or rock, reflection from rocks or sheets of water, and vegetation. There are many other influences by which climates are modified, and local climates formed; as, for instance, the cultivation of the soil, the drainage of marshes and damp grounds, the planting and the clearing away of forests, the increase or decrease of population, the establishing of manufactures.

The study of climates, or climatology, is as yet in its infancy. It is based on several other sciences, which are only in the beginning of their development, such as the meteorology of different parts of the earth, physical geography and comparative geographical physiology and pathology.

We can only endeavour to give the outlines of the subject in its present phase and its relation to health, and will (1) begin with a short consideration of the principal constituents of climate, and (2) afterwards describe different kinds of climates, and (3) consider in how far they may be rendered available for the maintenance or recovery of health, including the climate of home.

I. THE COMPOSITION OF THE AIR.

The most important factor of climate is the atmosphere or the air—the most necessary substance for the maintenance of life—*aër pabulum vitæ.*

It is not very long since it was maintained that the composition of the air was the same in all parts of the earth—at the tops of mountains or the sea-shore, in villages and in towns. More recent researches have shown differences not only in the principal constituents, but also in the more or less constant admixtures, and we are especially indebted to Tyndall, Frankland, and R. Angus Smith, for the light they have thrown on this subject. The latter* justly points out that the slightest changes are of the utmost importance, because the quantity of air which we inhale is so great. Air is to us the most indispensable agent, much more so than water and food. We cannot exist a minute without consuming a large amount of air, and, while the impurities of water can be rendered more or less innocuous by boiling, by chemical agents, and by filtering, it is much more difficult to effect a thorough filtration of the air before we inhale it. The respirators of charcoal proposed by Stenhouse are useful under certain circumstances, and still more so those of cotton by Tyndall, and those of a more portable shape by Frankland; but, simple though they are in principle, and ingenious in construction, their use requires a certain amount of trouble, and is, therefore, not likely to become general.

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* "Air and Rain." By Robert Angus Smith. London, 1872.

The average composition of atmospheric air, according to the analyses of Regnault, Bunsen, Dalton, Frankland, and Angus Smith, is in volumes :—

Oxygen	20·96
Nitrogen	79·00
Carbonic acid	0·04
	100·00

Other substances, of more or less constant occurrence in the air, are the vapour of water, ozone, common salt, ammonia, organic and inorganic dust, and, under certain circumstances, muriatic, nitric, and sulphuric acids, products of combustion of coal, and of decomposition of organic substances.

Oxygen.—The difference in the proportion of oxygen in the air of different localities rarely exceeds one-tenth, but considering, as already stated, the large quantity of air which we inhale, a slight deficit must be regarded as important, the more so, as such deficits are generally made up by the presence of more or less injurious substances.

In the same town different localities show considerable differences. Thus, R. Angus Smith found :—Near Belsize Park, 21·01 per cent. of oxygen; in the middle of Hyde Park, 21·005 per cent. ; in the eastern districts of London, 20·86 ; in the tunnels of the Metropolitan Railway, 20·70 per cent. At the same spot the amount of oxygen varies under the influence of weather ; it is higher in wet weather, or immediately after rain, than in dry foggy weather. Furthermore, the air of an open yard or garden before houses contains more oxygen than that within the rooms of the house. The air over ash-pits was found as poor in oxygen as that in the metropolitan tunnels. The action of the *nitrogen* in the atmosphere is as yet not known to us.

Carbonic Acid in the Air.—Carbonic acid is, as first shown by the De Saussures, a regular constituent of the air, 3·5 to 6 parts in 10,000. Its quantity varies at different localities, and at the same under different circumstances. Pettenkofer found a larger proportion in crowded schools at Munich—viz., 20 to 58 in 10,000 against five in the open air near them, and Angus Smith found in some law courts as much as 20, and in theatres 32 in 10,000.

It is not quite evident what the influence of slightly increased quantities of carbonic acid with human organisms is, for the experiments of the physiological and pathological effects of carbonic acid in large proportions are not applicable to such small amounts. It is possible, and even probable, that the injurious effects often ascribed to the latter are not due to the carbonic acid itself, but to other impurities simultaneously occurring in the air. To some degree the increase of carbonic acid may be regarded as an index of the latter. If we are unable to guess the influence of the minute quantities of carbonic acid on the human economy, we know more of its importance to the respiration and life of plants, and of their retaining the carbon and returning to the air the oxygen, which, when thus developed, may possibly be endowed with greater powers than the ordinary oxygen of the air.

Ozone.—The nature and action of ozone are not yet fully known. It is now generally regarded by chemists, as first suggested, I think, by Dr. Odling, as a condensed form of oxygen, while *Antozone* is peroxide of hydrogen. The re-agents for ozone are imperfect, but some of the results obtained may be regarded as trustworthy—viz., that there is no reaction of ozone in the neighbourhood of decaying substances and in crowded sick-rooms, that there is less reaction in the interior of large towns than in the open country, more over green fields and woods than over sterile plains or dusty roads, more at the sea-shore than in flat inland regions, more on the tops of mountains than on plains. Ozone possesses, according to Frankland, Thénard, and others, great powers of oxidation and disinfection. The quantity contained in the atmosphere is very small, rarely exceeding one part in 10,000. The idea of former years that its presence in the air favours the occurrence of acute inflammations must be considerably modified. It is true that physiological experiments have proved that ozone, more or less concentrated, causes intense irritation of the mucous membrane (Houzeau, O. Liebreich, and others); but this is not the case with such small proportions as are contained in the atmospheric air which we breathe.

Professor Binz, of Bonn, who has performed quite lately a series of interesting experiments on man as well as on animals, attributes to diluted ozone a soporific effect, and this is in harmony with the experience that many, though not all, persons sleep much better, and are apt to fall asleep much more easily, in air containing much ozone, such as the air of mountains and of the sea-shore. We may refer also to the labours of Tait, Andrews, Sir Benjamin Brodie, Soret, and C. B. Fox.

Antozone seems to have no direct influence on the human organism, but possibly plays a part in the changes of water from one form into another.

Ammonia, which is rarely absent, is of less importance to the animal economy than to that of plants.

A constant constituent of the atmosphere is the *vapour* of water. It is of great importance in the formation of climates. We shall, therefore, devote a separate sub-section to the *humidity* of the air.

The *solid substances floating in the air* are not necessary and constant parts of the atmosphere. They are of varying nature in different localities, and even at the same places under different conditions. They are almost wholly absent in the atmosphere of highly elevated regions with scanty habitations, and are very abundant in thickly populated regions of lower, or only moderate, elevations. They are partly inorganic, partly organic. The former consist principally of particles of salt, of silicious matter, chalk, iron, and other minerals; the latter of pollen grains, algæ, sporidiæ, bacteria, fragments of hair, of plants, of insects, of other animal tissues, &c.

The question of these floating matters is of the greatest interest in the appreciation of the air of different localities. Ehrenberg, Schwann, and others had already directed attention to the subject; Pasteur had proved the immense difference in the action of the air of glaciers and of only slightly lower inhabited regions; but Tyndall has thrown greater light on it by his electric ray, and we must constantly refer to his classical lecture on "Dust and Disease." Angus Smith has shown that the amount of air which a man breathes at Manchester in about ten hours contains about 37 millions of spores. Cunningham's researches into the floating matter contained in the air at Calcutta are likewise very instructive.

The realm of floating organisms, their nature and functions, offer a vast field for research. The recognition of their influence on wounds by Lister and his followers, and the adoption of successful measures to prevent their often deleterious influence, form, we may say, an epoch in the history of surgery; and we look forward with intense interest to the further discoveries of their connection with many species of fever, and other constitutional diseases, already indicated by Schwann, William Budd, Pasteur, Sanderson, Klein, and others. We know, however, that not all floating organisms are injurious to health, and Tyndall's suggestion of the usefulness of some as agents of light, of purification, and metamorphosis of matter, open up important points for further inquiry.

II. Temperature.

Temperature is one of the most important constituents of climate; it exercises a powerful influence on organic life, and it calls forth and modifies most of the other climatic agents.

The principal and almost entire source of heat in the atmosphere and surface of the earth is the sun; the additions derived from the moon, the stars, and the interior of the earth being comparatively insignificant.

We generally distinguish between radiant heat or sun heat, and shade heat or air heat. The radiant heat, that is to say, the heat radiated from the sun, has great direct power of warming the human body and other solid and fluid bodies on which it falls, but only slight power of heating the air through which it passes, as the gaseous constituents of the latter, excepting the vapour of water, are unable to absorb the heat of the sun's rays. They are, to use another expression, diathermic or transcalent. The shade temperature is produced principally by the communication to the air of the warmth which the sun's rays had previously imparted to the surface of the earth—viz., land and water. The shade temperature of a place at a given time is, however, not entirely caused by the emanation of heat from the surface of the place itself, but partly by currents of air or winds from distant regions.

When we mentioned just now the diathermancy of the air for the sun's rays—viz., the quality of the air to let the heat or thermal rays pass through without retaining the heat, we alluded to the water vapour, without which the air would be absolutely diathermic; but, as there is always a certain amount of water vapour in the air, a certain amount of the incident heat is retained in the atmosphere proportionate to the quantity of vapour contained in it; another part is absorbed by the surface; and a third portion is reflected back into the air. This latter has a considerable share in warming the layer of atmosphere surrounding the earth, for, as we learn from Melloni and Tyndall, the water vapour is much less diathermic to the invisible waves of heat radiated back from the earth than to the direct luminous rays of the sun. Without this circumstance, our planet would be much colder, especially during the night, when all the warmth absorbed during the day would be rapidly radiated into space, which in fact to some degree occurs when the air is comparatively dry. We shall return to this important subject in discussing the difference between dry and moist climates.

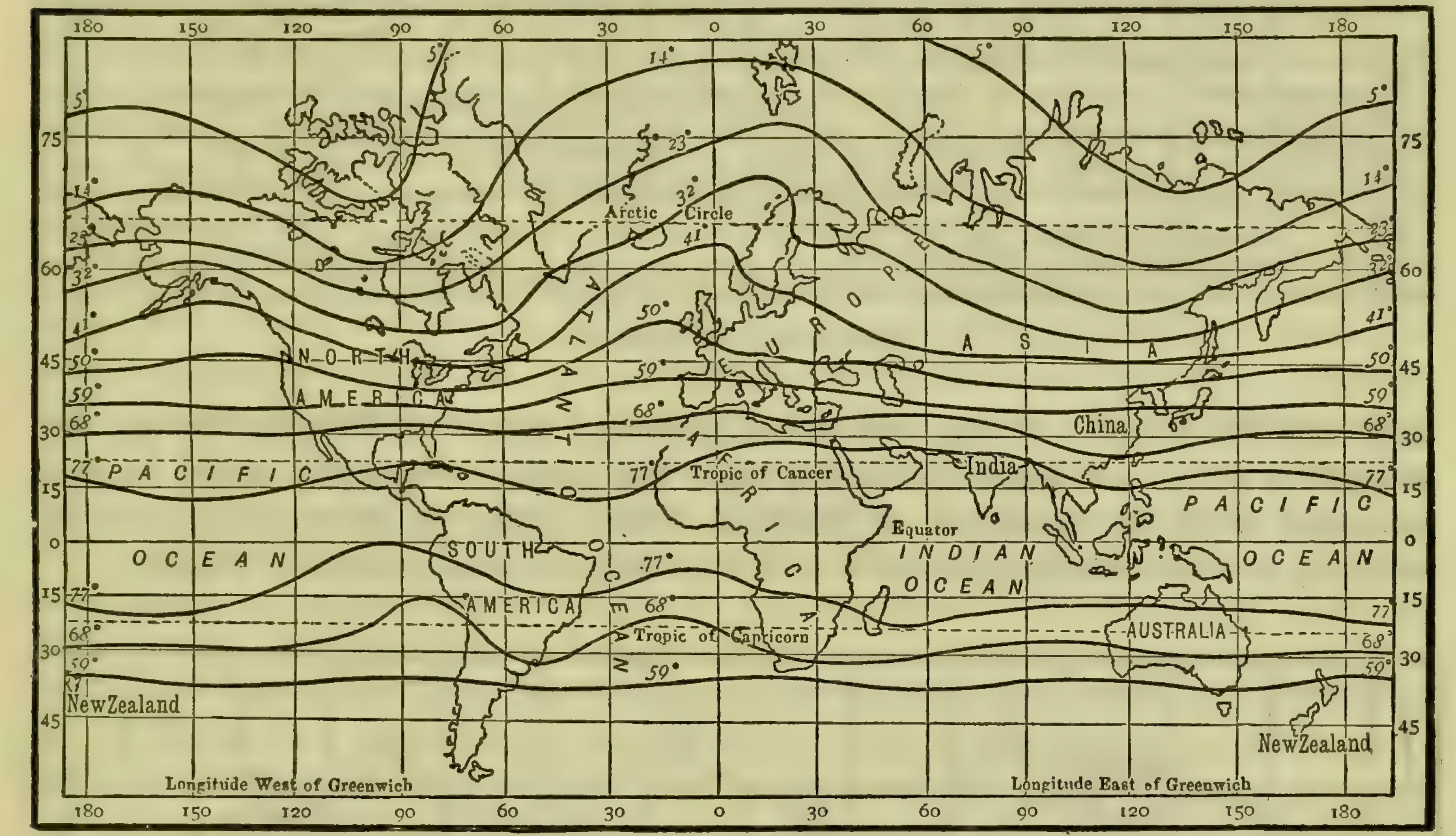
On both the air (or shade) temperature and the sun temperature, the nature of the surface upon which the sun shines has a great influence, as the amount of heat which is reflected, and which is absorbed, varies very considerably according to the surface. Dr. Frankland, having made numerous experiments, found white paper, white linen, and snow the best reflectors; mirrors and light-coloured soil less good; green grass, black silk, or black merino endowed with the lowest power of reflection.

As the absorbent powers of substances are inverse to their reflective powers, it follows that bad reflectors become hot in sunshine, and later impart the heat to the surrounding air; while good reflectors remain cool, and can therefore not give out so much heat. Frankland justly points out the bearing of these facts on "climate." The nearer the colour of the ground approaches to white, the greater will be the sun-warmth and the cooler the air; whilst the darker the colour, the warmer will be the air, and the less will the heat of solar radiation be felt.

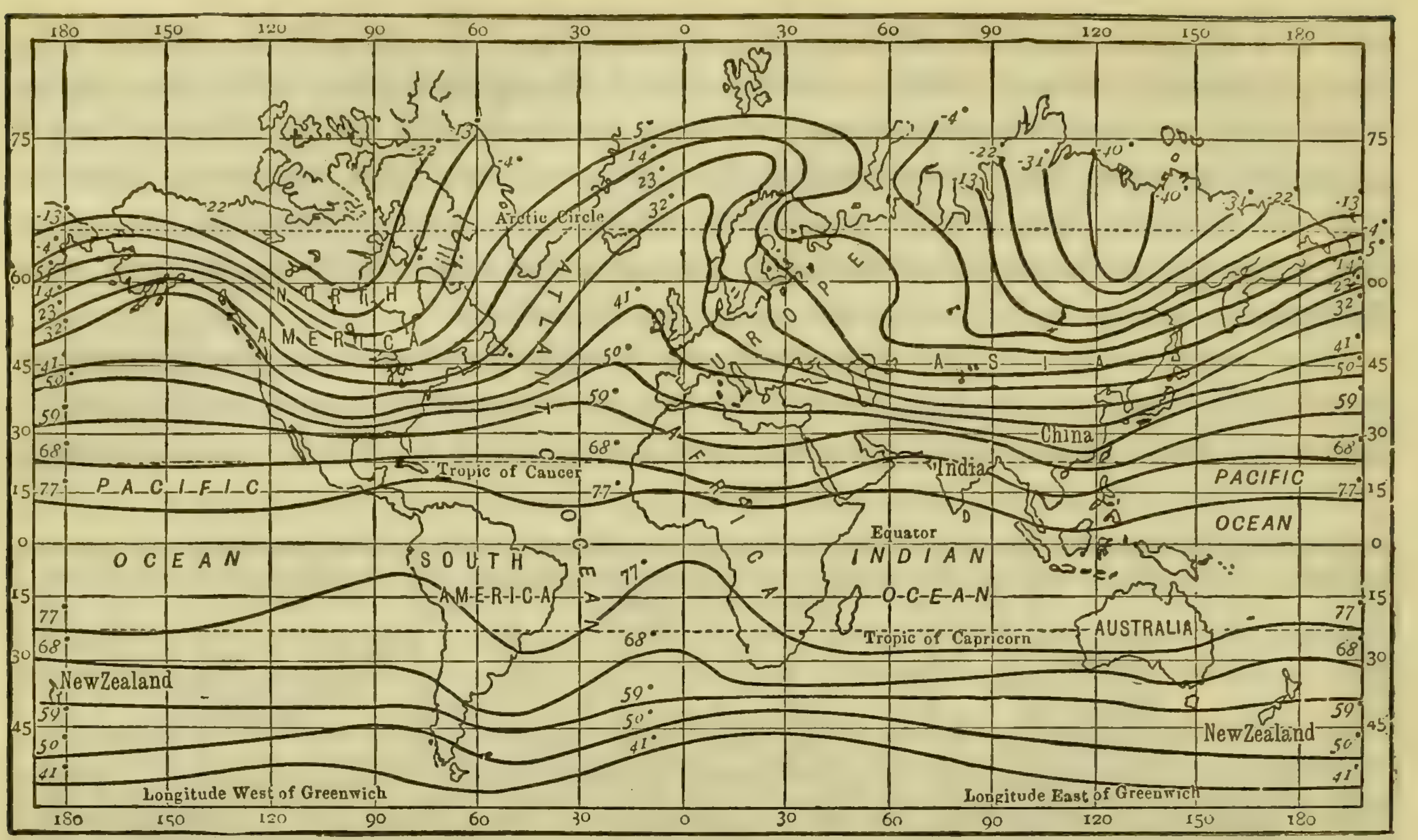
By reflection, the radiant heat of the sun is more or less augmented, according to the nature of the reflecting substance. Frankland compares the natural reflectors to artificial ones, and divides them into those which, like white paper, scatter the reflected light in all directions, and those which, like mirrors, throw them in one definite direction only. To the former belong snowfields, light-coloured rocks, and light-coloured surfaces in general; to the latter, the sea and inland sheets of water. We know how greatly the sun-warmth is assisted in winter at localities like Davos and St. Moritz by the sunlit snowfields, and those who climb the higher Alps in summer feel it often to their regret when ascending a steep snow slope with the full sun on it. We know, also, how white chalk cliffs and whitewashed houses and high walls increase the sun-heat. On the other hand, the sea and inland lakes reflect a defined image of the sun, and the advantage is felt only when the sheet of water is between the sun and the object to be warmed, but it is then sometimes very considerable. Frankland found at Alum Bay, Isle of Wight, the reflected heat from a ruffled sea, at 6.45 p.m., in May, amounting to 44 per cent. of the direct solar heat. The lower the altitude of the sun, the greater the increase of warmth by reflection from water; hence, in winter, the great advantage in removing the cold of mornings and evenings.

Distribution of Temperature in the Atmosphere.—We have already mentioned that the temperature of different localities does not depend on the distance from the equator alone, because the surface of our globe consists neither of a homogeneous fluid mass, nor of strata of rock perfectly alike in colour, density and smoothness, and of equal capacity both for the absorption of the sun's rays and for radiating heat through the atmosphere. It can only be roughly said that in a zone of unequal width, on either side of the equator—*i.e.*, within the tropics—the mean annual temperature at sea level is about 80° to 85° Fahr.; that it gradually decreases from there towards the poles, and that with increasing distance from the equator, the difference between summer and winter increases, owing to the greater perpendicularity of the sun's rays, and the longer daily insolation during the former, and the opposite conditions during the latter.

Isothermal lines.—A. von Humboldt was the first to show in a graphic manner on charts the lines connecting places which have the same mean annual temperature—*isothermal lines*; those which have the same temperature in winter—viz., January, *isochimenal lines*; and those which have the same temperature in summer—viz., July, *isotheral* lines. If there were no causes leading to deviations, these lines would be parallel to the equator, but a glance at the accompanying charts shows that they form distinct concavities and convexities—*i.e.*, that in their course round the globe they curve considerably towards the north in some regions and towards the south in others, showing that the temperature is above or below what would be expected if there were no disturbing influences. They further show that on the northern hemisphere there is a great difference between the course of the winter, the summer, and the annual isothermals. The *winter* isothermals are seen to *rise* considerably towards north in the Northern Atlantic, in the British Islands, including the Orkneys and the Shetlands, in Iceland and the west coast of Norway; and to *descend* towards the equator in the interior of the continents of Asia and America, while the *summer* isothermals manifest an opposite course. We learn from this that the corresponding

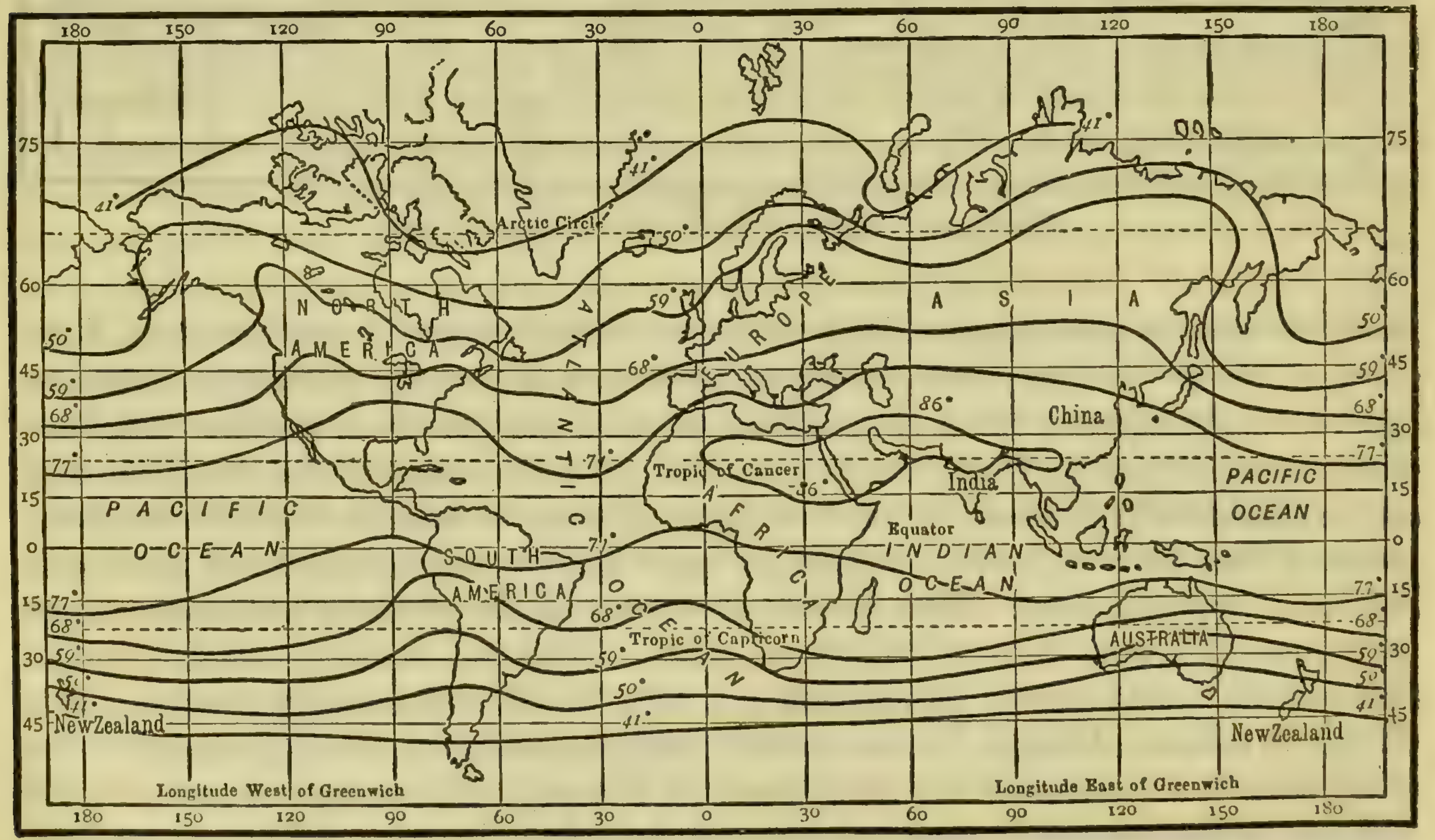


Isothermal Lines of Mean Annual Temperature.



Isothermals of January.

regions of the Atlantic Ocean, with the islands and coasts of Western Europe, are warmer in winter and cooler in summer than the annual isothermals would lead us to expect, while the continent of Northern Asia is colder in winter and hotter in summer, and that North America is colder in winter and temperate in summer.



Isothermals of July.

In the southern hemisphere the temperature lines are less deviating than in the northern, and with greater distances from the equator they become nearly parallel, excepting where the continents of South America, Africa, and Australia interfere.

Disturbing causes of the Solar Climate.—The observation of the deviations thus roughly sketched has induced Humboldt and others to enquire for the *disturbing causes of the solar climate;* and we may, with Humboldt, divide them into A, influences which *raise the temperature* above the average; and B, such as *depress* it.

(A) *Warming Influences.*—Amongst the *raisers* of *temperature* are warm oceanic currents; vicinity of the West Coast in the northern temperate zone; "a divided or intersected configuration of the land, with projecting peninsulas and deep re-entering bays;" in the colder regions, position of the land near a sea free from ice extending into the polar circle; in the warmer regions, the nearness of a considerable mass of continental land extending into the torrid zone; prevalence of warm winds, southerly and westerly in winter, and easterly in summer, in the northern temperate zone; chains of mountains acting as protecting walls against winds from colder regions; serenity of sky during the summer months.

We must refrain from entering into details with regard to all these different influences, but we will call attention to some of the more important relations of *water*, and especially of the *sea*, to climate. Physicists have shown us that the specific heat of water is considerably higher than that of land, averaging about 4 to 1; hence water takes longer to warm as well as to cool. Water allows the rays of the sun to pass to a greater depth than land; hence the surface does not warm so rapidly. The circumstance that the air above the surface of water contains more vapour checks the loss of heat by radiation, and as soon as by the latter cause the upper layer of water becomes colder than the lower, the latter ascends to the surface while the former sinks to the bottom; hence the refrigeration of the surface of a body of deep water, and of the air resting on it, is much less great than is the case with land during a clear and calm night. The surface temperature of the sea near the Scottish coast varies on the average only 0°·6 Fahr. in twenty-four hours, while on land the average variation in Scotland is about 12°, and the maximum daily variation of the water of the sea is 5°·6, while on land it is sometimes as much as 80° and even 90°. Analogous facts have been observed with regard to deep and extensive inland lakes, but they are much less striking, for there are considerable differences in the behaviour of sea water and fresh water, especially in low temperatures. While fresh water, after having sunk to the temperature of 39°·2 (its greatest density), ceases to contract and to become heavier, but on the contrary, expands and becomes lighter till it reaches freezing-point at 32°, sea water, owing to the salts which it contains in solution, continues to contract and become heavier till its temperature has sunk to 26°·2, freezing-point being about 27°·5 to 28°·4. Owing to this circumstance the surface of sea water cannot freeze till the temperature has fallen through the whole of its depth to 28°·4, while, in fresh-water lakes, the surface water does not descend after the water through all its depths has fallen to 39°·2 and may freeze while the lower depths retain a temperature of 39°·2; and when frozen over, inland lakes cease to act on the climate as large masses of water.

The sea, on the contrary, remaining open, excepting in the highest polar regions, influences by its temperature the strata of air coming in contact with it and the adjacent coasts, and thus moderates the heat in summer and the cold in winter.

From these considerations it is evident that the temperature of the sea in different parts of the globe must exercise great power on the climates of adjacent lands. We have to distinguish between the *surface* temperature and the *deep-sea* temperature; the latter are at great depths almost everywhere the same—viz., about 32° to 35° Fahr. The former vary considerably in different regions, though much less so than the land temperatures. Within the tropics the variation in different localities varies only between about 80° and 85°·5, while in the latitudes of the British islands it varies in different localities and seasons between about 35° and 60°.

An essential point in the climatic influence of the sea is, that the water is not at rest, but that, on account of its fluidity and the differences in temperature, there is a constant communication between different parts of the seas by means of currents. The most powerful and the most widespread influences are produced by what may be called the *general oceanic circulation.* This mainly consists in an *underflow of cold polar* water from the polar regions towards the equator, and an *upper flow of warm equatorial* water from the equator towards the poles. Warm water is in this way constantly carried along the surface from hot to temperate and cold regions. Dr. Carpenter refers to this circulation, and not to the Gulf Stream, "the sharp northward turn which the isothermal lines take round the corner of Newfoundland," and the passage of warm water through Smith's Sound (at the head of Baffin's Bay) ameliorating the climate of the western shore of Greenland, and carrying tropical products, such as logs of mahogany, to Disco Island. This surface stream, on reaching the polar regions, is gradually cooled, and then sinks to the bottom, and returns as the underflow of polar waters to the equator. This deep polar current, although in general at the bottom of the sea, comes in different localities to the surface, forming bands of cold water and cold currents along shores, to which we shall refer farther on.

By the influence of unequal heat and distribution of land, especially the formation of coast lines, and by the action of prevalent winds, other sea currents are produced, causing deviations in the general oceanic circulation and in the distribution of temperature. The best known of these currents is the *Gulf Stream* or *Florida Current.* It is very probable, however, that, as Carpenter maintains, much has been ascribed to the Gulf Stream which is in reality effected by the general oceanic circulation—viz., by the general equatorial stream, and by warm *air* currents or winds. The former idea was that this warm current went from the Florida Channel in a northerly direction to off Cape Hatteras, and then in a north-easterly to the south of Nova Scotia, after which it turned nearly due east towards the British Isles, and was supposed to extend not only to Iceland and the Norwegian shores, but also to the west coast of France. It is certain that the British Isles and the west coast of Norway are 15° to 20° Fahr. warmer in winter than localities situated in the same latitudes in the interior of America and Asia; but a great part of this elevation of temperature is no doubt due to the warm northward-flowing equatorial current and to the south-west winds, laden with latent heat in the shape of water vapour.

Carpenter, indeed, renders it very probable that only a small portion of the actual Gulf Stream is traceable beyond the meridian 30°; that it is practically dispersed as a distinct current by the process of thinning off and superficial extension; but that the prevalent westerly and south-westerly winds carry a certain amount of the warm water brought into the Mid-Atlantic by the Gulf Stream in the direction of the British Isles, Norway, and Spitzbergen. The course of the isothermal line seems to show that "what is left of the Gulf Stream to the west of the meridian of 30° turns to the southward in the neighbourhood of the Azores, and is drawn into that North African current which is one of the principal feeders of the equatorial." Carpenter concedes, however, that two or three bands of the original Gulf Stream, of higher temperature than the rest, seem to have a definite movement of their own, although the course and rate of that movement are considerably influenced by prevalent winds. "The principal of these, known as Rennel's Current, flows eastward (especially when west or south-west winds have prevailed) into the southern part of the Bay of Biscay, and is turned into a north-west direction by the trend of the coast-line, so as to cross the Channel towards the Scilly Islands, and thence to pass to the south-west coast of Ireland." "There is, again, a tolerably constant band of temperature a little higher than that of the sea on either side of it, passing north-east between the Shetland and Faroe Islands; and another has been met with, though more variable in its position, between the Faroes and Iceland."

Among the other warm sea currents the best known are one along the east coast of South America from the equator southwards, which raises the temperature of this coast by several degrees, and another along part of the east coast of Africa, raising the temperature in the Gulf of Mozambique to 81° Fahr. There is also a comparatively warm current in the North Pacific, called Kuro-Siwo, which runs up into Behring's Straits.

Further investigations into the nature of the different currents of the sea are likely to be of great value to climatology, and of still greater value to navigation, so that we may hope for wider information on this subject.

Climatically it is of importance to know that not all the parts of the sea have the same glacial and equatorial currents as the great open Atlantic and Pacific. A notable exception are the inland seas, with shallow communications; and amongst these that which interests us most is the Mediterranean, which is free from polar currents, and even at its greatest depths of from 1,500 to 2,000 fathoms has a temperature of 54° to 56°, while in the Atlantic, outside the Strait of Gibraltar, the water at the same depths is only 36°·5 to 37°. The explanation of this peculiarity, no doubt, is to be found in the fact that the Strait of Gibraltar is so shallow as not to admit the deep polar streams of the Atlantic.

Among the other influences which raise the temperature, *warm winds* play an important part. It is generally understood that winds carry with themselves the temperature of the regions from which they come; that in Africa, for instance, winds coming from the heated desert bring great heat to the countries to which they blow;

that in Australia during summer, winds blowing from the heated interior towards the coast often raise the temperature several degrees; and that in Europe during summer, east winds blowing from the heated continent of Asia produce a marked rise in temperature. These are generally dry winds. Somewhat different is the case with the moist south and south-west winds during the colder seasons in the British Isles and the whole west coast of Europe. They are sometimes, as measured by the thermometer, scarcely warmer than the air of the country which they reach, but their warming effect is much greater than the thermometer indicates, as they bring a considerable amount of vapour, which, on becoming condensed as rain or snow, sets free the latent heat by which, in tropical and sub-tropical regions, it had been transformed from the fluid into the gaseous state. Thus, part of the heat of the tropical sun is carried to us during winter in the form of aqueous vapour. Another portion of the heat brought to our regions by south and south-west winds is derived from the warm sea currents over which they have passed; and in this way, no doubt, the Gulf Stream sends warmth to us, though not actually reaching our shores as an active current.

(B.) *Influences which depress the mean temperature.*—Humboldt mentions elevation above sea level; the vicinity of the eastern coast in North America; the compact and massive form of a continent, having a coast line little varied by indentations; an extension of land in the direction of the pole, far into the frozen regions, without an intervening sea free from ice during winter; a geographical position in which the tropical portions of the same meridians are occupied by sea; chains of mountains, which, by their direction, height, and precipitous form, impede the access of hot winds; extensive forests, operating in a threefold manner—by shade, evaporation, and radiation; extensive marshes, which in cooler countries retain underground ice until summer; a cloudy sky and misty air in summer impeding the sun's rays, and a serene sky in winter, favouring loss of heat by radiation; prevalence of cold winds.

The neighbourhood of the sea belongs, in the temperate regions, to the cooling influences in summer, as much as it belongs to the warming influences in winter.

Cold sea currents are powerful local depressors, just as warm currents are raisers, of temperature. Thus, on the west coast of South America, Humboldt's current, due to the polar current of the South Pacific Ocean; the polar currents descending on the east, and to a lesser degree also on the west coast of North America; the cold currents on the west coast of Africa, on the east of Asia, and on the south of Australia.

We have already mentioned the influence of the great *fresh-water lakes* of North America in diminishing the summer heat, and the loss of their warming influence during winter as soon as they are frozen. Brackish waters which become frozen during cold winters lose their temperating influence on the air as soon as this occurs; a fact which is not rarely witnessed on the Baltic, and is traceable in the isochimenals of January.

The *decrease of the mean temperature with increasing elevation* is regarded almost as a law, but it is by no means so uniform as the decrease of pressure, local conditions also producing exceptions. In the Swiss Alps the brothers Schlagintweit found a mean decrease of 1° cent. for an elevation of about 540 feet, or of 1° Fahr. for 300 feet; Humboldt found the decrease somewhat less in the Andes. In winter it is less than in summer. We shall return to this subject in considering the properties of mountain climates; mentioning here, however, that during the night in valleys the temperature at the bottom is often lower than it is higher up on the slopes.

The *mean annual temperature* of a locality shows us the amount of heat which the latter receives in the course of the year; but this is of rather restricted value for medical considerations, as widely different climates may have the same annual temperature. Dove's meteorological tables furnish ample instances. We will only compare Dublin and Munich with nearly the same annual temperatures—viz., between 48° and 49°; but the winters at Munich are about 9° colder than at Dublin, and the summers nearly 6° warmer; or Bergen and Potsdam with an annual mean of about 47° Fahr.; but the mean winter temperature of Potsdam is below freezing point, while that of Bergen is 5° above; the summer temperature at Potsdam, on the contrary, being nearly 8° higher. Such differences are of great importance with regard to the health conditions of the inhabitants, as the great heat of summer in climates like Munich and Potsdam gives rise to a much larger amount of diarrhœa, especially amongst children; and the greater cold of winter increases the dangers of old age.

Of greater value to medical climatology is the knowledge of the mean temperature of *every season* and of *every month*, as Dove's monthly isothermals indicate. Even this knowledge, however, is insufficient, and it is necessary for us to know the temperatures of every week, the maxima and minima of every week and of every day, and still more how the temperature is, as a rule, distributed between the various hours of the day, as in this way alone we are enabled to indicate during which hours delicate persons can or ought to be in the open air.

Our knowledge of the influence of different degrees of warmth on the human organism is, as yet, very imperfect. Pflüger and Voit have shown by experiments that *cold* acts as a stimulant, and that the amount of carbonic acid exhaled is increased by moderate degrees of cold, a result which agrees with generally received views. More astonishing is Pflüger's experience that *heat* likewise causes an increase in the exhalation of carbonic acid, a result quite in accordance with Marcet's researches on the island of Teneriffe. (Proc. Roy. Soc., 1879.) Instructive upon this point are the experiments of Duke Carl Theodor in Bavaria, showing that the tissue change is increased during the ordinary winter cold, and is diminished during summer and in warmed rooms; and that the same amount of food which in winter just suffices to keep up the body weight, leads in summer to increase of weight. The general views of climatic influence of temperature are based partly on the effects of different seasons on the health of individuals, partly on the effects of moving from a colder to warmer climates, and *vice versâ*, partly on the consideration of the physical and mental constitution of peoples dwelling in hot and cold regions; but under all these circumstances, different climatic factors (moisture, light, electricity, different degrees of elevation) are combined with differences in temperature, and the inference is rendered still more difficult by changes in the manner of living and in hygienic conditions, and occasionally by malaria.

It is always necessary to distinguish between *radiated* heat or *sun-heat*, and *shade-heat*. It is not yet known how great a degree of sun-heat can be borne by man without harm. It is certain that sun-stroke rarely or never occurs in high elevations, where the sun-heat is very great, the air pure and comparatively dry, and that it is also excessively rare on the high ocean, where the heat of the sun's rays is as great as anywhere. A much greater degree of heat is borne when the air is in movement than when it is perfectly quiet, and greater also when the individual is moving than when obliged to be still.

The effects of high degrees of *air* or *shade temperature* are less easily borne than the same degrees of sun-heat. This is no doubt due to the fact that, when the air in the shade is hot, it contains also a considerable amount of moisture, and that evaporation and its cooling influence are thus checked. A shade-heat of 90°to 100° is very overpowering, and the same people who can sustain prolonged hard work in a sun-heat of 120 become rapidly fatigued in a shade-heat of 90° to 95°. Much, however, depends on the degrees of moisture and the movement of the air, and probably the electric condition. There is also considerable individual difference regarding the ability of bearing high temperatures. Europeans in India and other hot climates often render themselves unfit to bear high temperatures by continuing to take the same amount of food and stimulants, and to wear the same clothing as at home. We need only refer to the testimony of Ranald Martin, Parkes, Fayrer, and others.

We quite agree with Dr. Parkes that "the effect of great heat in shade seems to be, as far as we can judge, a depressing influence, lessening the nervous activity, the great functions of digestion, respiration, sanguification, and, directly or indirectly, the formation and destruction of tissues. Whether this is due to heat alone, or heat and lessened oxygen, and great humidity, is not certain."[*] In accordance with this inference is the general impression that Europeans do not flourish in countries where the mean temperature is about 20 degrees higher than in their native land, that they lose vigour, and die out within a few generations unless intermixed with the races of the hot countries.

In the treatment by climate, we have, however, much less to do with high than with *moderate degrees of heat*—viz., from 55° to 70° Fahr., such as we find them during the summer months in temperate, and during the cooler seasons in hot, climates. The general effect in all persons is that the loss of body heat is less than in lower temperatures; in *strong* and *healthy* persons, we often find diminution of appetite, of the functions of digestion, respiration, circulation, tissue change, and urinary secretion, together with a certain degree of mental and muscular lassitude, while the function of the skin is increased. *Weak persons*, on the other hand, frequently manifest greater energy of all the functions of mind and body, and less liability to disease. Many of this class gain in weight, and some seem only to live when surrounded with warmth and sunshine. Hence, the value of such climates to permanently delicate and temporarily weakened individuals, as well as people of advanced age.

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[*] "A Manual of Practical Hygiene." By E. A. Parkes, M.D.; Ed. by F. S. B. de Chaumont, M.D. Fifth Ed.; London, 1878. Page 436.

Influence of Low Temperatures.—The effects of *low temperatures*, like those of high, present themselves to us rarely in so simple a form as to allow us to form clear inferences; but the one point certain is, that the body loses more heat, and is called upon to supply this loss. We shall leave out of consideration continued great degrees of cold, because these rarely form part of medical treatment, and restrict ourselves to the cold experienced in the winters of temperate and moderately cold climates. These, we find, are well borne by *healthy* and *vigorous individuals* when sufficiently supplied with clothing and food; and certain deviations from health, without actual disease, such as a sluggish venous circulation, torpor of intestinal organs, retardation of tissue change, with its consequent bodily and mental hebetude, are favourably influenced in such constitutions; respiration, circulation, and sanguification are improved, the tissue change is accelerated, the mental and bodily energy appear to be increased. The opposite, however, is the case with *really delicate persons.* Amongst these we find many who, during our ordinary winters, and in colder winters of warmer climates, never are free from catarrhal or rheumatic conditions; others remind us of the state of hibernation by the torpor of all their functions: they are bluish and cold, appetite and action of bowels are at a standstill; there is a disinclination to every kind of mental and bodily activity; in others, only certain spheres appear affected, as the secretion of bile, leading to inspissation, or concretions, and an icteric condition. In some females irregularity or total cessation of menstruation are the usual effects, while these functions are regular in summer and warm climates.

It is especially amongst those advanced in years that we find many who are unable to bear low temperatures. The reports of the Registrar-General furnish us with ample proof of this. In the last quarter of 1878, for instance, including two very cold months, the mortality of people above sixty was 24 per cent. higher than in 1877, when the same period was characterised by mild weather; the rate of increase amongst those below sixty was only 8 per cent.

We must, however, bear in mind that it is incorrect to ascribe all the injurious effects of our winter cold to the low temperature alone; for at one time the latter is accompanied by much moisture and wind, through which our loss of heat is much increased; at another time it is associated with more or less dense fogs, which deprive us of light, force us to inhale the products of imperfect combustion and other injurious substances, and check to some degree the pulmonary and cutaneous excretions. The circumstance that cold is disagreeable to most persons induces them to see in it one of the most injurious climatic agencies. That, however, this view is not correct we may learn from the fact that up to a certain degree the rate of mortality decreases as we proceed from the equator towards the poles. Thus, Michel Lévy gives the following table in his "Hygiéne":—

From	0 to 20	degrees latitude,	1	death to	25	inhabitants.
,,	20 ,, 40	,,	1	,,	35·5	,,
,,	40 ,, 60	,,	1	,,	43·2	,,
,,	60 ,, 80	,,	1	,,	55·0	,,

A further proof that moderate degrees of cold are not injurious to healthy persons, to mental as well as bodily development, is found in the fact that the emigrants from France settled in Canada have by no means deteriorated, but are, on the contrary, more robust than the inhabitants of the country from which they emigrated; and that the people of Sweden and Norway are by no means inferior to the Teutonic tribes inhabiting the central and more southern parts of Europe.

III. Humidity of the Air.

The degrees and different conditions of the humidity of the air are most important elements of climate. Water in the shape of vapour is, as already mentioned, a constant constituent of the atmosphere, even of the brightest and most transparent. It is a perfectly impalpable gas, as much so as nitrogen and oxygen; but while the two latter, as far as our present knowledge goes, always remain in the gaseous state, and in the same proportion, the quantity of aqueous vapour is constantly changing by the ceaseless processes of evaporation and condensation.

The amount of water-vapour which the air is able to hold is comparatively small; warm air is able to hold more than cold air; the *capacity of the air* for *water-vapour* increases in direct proportion to its temperature.

It is well known that the amount of water-vapour contained in a certain space of air is called the *absolute humidity*, while the proportion of vapour actually contained in the air to the amount which it could contain when fully saturated is called the *relative humidity*. When speaking of *dry* air and *humid* or *moist air*, we mean that the *relative* humidity is low or high.

The degree of *absolute humidity* of the air varies with the *seasons ;* it follows to some degree the changes of temperature : it is higher in summer than in winter; the variations are greater in continental than in sea and insular climates. There are also *daily* variations, which likewise in the main correspond to the temperature. These daily changes in the *absolute humidity* vary considerably in different climates, and in the same climate and even in the same season, according to the state of the sky, the movement of the air, and other varying conditions.

The variations in the *relative humidity* are rather different; they follow to some degree an opposite course. As the capacity of the air increases with increasing temperature, and as the addition of moisture from evaporation generally does not keep pace with the rise of temperature, the *relative humidity* is, as a rule, lower in summer than in winter—lowest mostly in May and June—highest in December and January. As to the different periods of each day, the greatest degrees of moisture are generally found about sunrise—the lowest during the first afternoon hours. These variations are much greater in summer than in winter—greater, also, in inland than in marine climates. The nature of the predominant winds exercises great influence on the degree of atmospheric humidity.

If the temperature of the air becomes lowered, the relative moisture rises, and if this continues up to saturation, condensation of vapour occurs, which on solid bodies shows itself as *dew*, and away from them in the shape of water-vesicles, or minute ice needles, which, accumulated in large masses form *mists* and *clouds*, between which there is no real difference. The frequency and nature of mists, and the periods of their occurrence, are of great importance in the influence of climates; and not less so the amount of clouds, which obscure or modify the sun's rays. Mists are less frequent at considerable elevations above the sea; clouds more frequent at certain moderate elevations. The latter are transformed into rain or snow under the influence of colder temperatures and changes of pressure, while they are dispersed or evaporated by increase of temperature, as we can see every day in mountainous regions. Winds, through their states of temperature, moisture, electricity, and velocity, are intimately connected with the conditions of clouds and of rain.

Rainfall in different regions of the earth varies considerably from zero, as in the desert of Sahara and on the coast of Peru, to several hundred inches, as on the south-east slopes of the Himalayas, which are exposed to the moisture-laden monsoons. The circumstances on which the amount of rain depends are partly *general*, such as degree of latitude and elevation above sea-level; and partly *local*, as nearness of large surfaces of water, exposure to moist winds, adjacency to mountain chains. As to the distribution of rain, according to latitude the amount decreases, as a rule, with the increasing distance from the equator towards the poles; but this rule has many exceptions, such as the rainless tracts already mentioned, and lesser deviations in the positive and negative direction. The amount of rain which falls in different regions is not proportionate to the moisture of the air, for a region may be almost free from rain, in spite of a humid atmosphere, if there are no cold winds causing condensation, as is the case with Lima, on the coast of Peru; and, on the other hand, localities with considerable rainfall may enjoy tolerable dryness of air and soil, as the Gulf of Genoa. Elevation above sea-level does not seem to exercise the same influence in different regions. Gasparin and others assume that with increasing elevation the amount of rainfall increases, and according to Chaix this is the case with the Swiss Alps, subject to certain exceptions; but no such rule holds good for America. The *neighbourhood of the sea* is for the west of Europe and the islands belonging to it a cause of increased rainfall.

The *number* of rainy days by no means corresponds to the amount of rainfall. It may even be said that the number of rainy days increases with the distance from the equator, while the amount of rainfall decreases. Thus, in the northern hemisphere, the average number of rainy days during the year, between latitudes 12° and 43° is 78; between latitudes 44° and 46° it is 103; between 47° and 50° it is 134; between 51° and 60° it rises to 160 and 178. The number of rainy days is important for the medical appreciation of climate; and it is also necessary to note the hours during which rain falls, for on this depends to some degree the time which the invalid can spend in the open air. In the region of calms it rains every day. The sun rises in general in a clear sky; about mid-day clouds appear, and soon gather to dark masses, from which large quantities of rain pour down. Before sunset the clouds mostly clear off, and the nights are perfectly serene.

It is a general idea that considerable rainfall is an injurious element in health-resorts; but this view is not quite correct. If the rain is not so constant as to prevent exercise in the open air, it has the advantage of purifying the atmosphere of dust, and of rendering it more refreshing, perhaps by the function of ozone, and the diminution of relative humidity: many people, at all events, perceive increased energy during and after rainfall.

Equally vague is the opinion that *snow* is injurious to delicate constitutions. The frequent melting of snow, it is true, is apt to produce catarrhal conditions; but where the snow remains on the ground for long periods without melting it acts beneficially in several ways:—1, the air remains more free from impurities rising from the soil, and also from dust; 2, the air is more transparent and translucent; 3, the reflected heat of the sun's rays is much increased, as snow forms the best natural reflector; 4, snow prevents the heating of the ground by the sun and the local currents of air due to this.

The moisture of the air is maintained, in spite of constant rainfall, by the process of *evaporation.* The *power* of evaporation possessed by the atmosphere of a certain region depends on the temperature, the relative humidity, the density, and the degree of motion. It is increased by rise of temperature, dryness of the air, and by wind; it is diminished by sinking of temperature, absence of sun, stillness of air, and high degrees of relative moisture. The degree of evaporative power of the atmosphere is of climatic importance, as the amount of evaporation from the body depends on it, by which not only our sensations as to warmth are influenced, but also the actual production and loss of heat, the functions of respiration, and tissue change.

The moisture of the atmosphere is as essential to the organic life on our globe as its oxygen; it is the great regulator of the distribution of warmth over the surface of the earth. It moderates to some degree the heat and light of the sun's rays, and it acts still more powerfully, as Tyndall has shown, by absorbing the heat rays reflected from the earth. Without the moisture contained in the air, the ascending heat waves would be rapidly imparted to the higher regions, and would be lost to our planet; "but," to use Tyndall's own words, "the aqueous vapour takes up the motion, and becomes thereby heated, thus wrapping the earth like a warm garment, and protecting its surface from the deadly chill which it would otherwise sustain." We can clearly trace this in climates where the air is dry; there the sun's heat during the day reaches the earth unimpeded and produces a high maximum, while by night "the earth's heat escapes unhindered into space, and renders the minimum low." The air-vapour saves the earth's heat, however, not only by taking up the heat rays at some distance from the soil, but it checks escape to some degree on the surface itself; for by nocturnal refrigeration the aqueous vapour immediately over the surface is condensed to water; "and, as only the superficial portions radiate, the act of condensation makes water the radiating body. Now, experiment proves that to the rays emitted by water, aqueous vapour is especially opaque. Hence the very act of condensation, consequent on terrestrial cooling, becomes a safeguard to the earth, imparting to its radiation that particular character which renders it most liable to be prevented from escaping into space." (Tyndall.)

Owing to these circumstances climates with moist air are more equable with regard to day and night, and also sun and shade. Excess of moisture, however, especially when combined with low temperature, may almost entirely shut out for days and weeks the direct light as well as heat of the sun, by which the climate loses its exhilarating character.

Although *atmospheric moisture* exercises important influences on man, it is difficult to define these influences accurately, as it is almost impossible to separate them from the effects of temperature, atmospheric pressure, light, and movement of the air. The degree of *absolute moisture* tells principally on the respiratory functions, as the inhalation of drier air leads to greater loss of fluid through the breath; hence profuse expectoration is often considerably diminished or entirely checked by residence in dry climates. The *relative moisture* is of special influence on the skin, as, according to it, a smaller or larger amount of fluid is imparted to the latter. In *dry* and *warm* air the skin parts with much moisture; in dry and cold air the loss through the lungs is specially great. In *moist* and *warm* air the evaporation of the skin is limited, especially if there is no wind; the skin is, therefore, not much cooled: the perspiration accumulates in the form of sweat, which permeates the clothing, and may, under the influence of sudden depression of the surrounding temperature or draughts, lead to chilling of the surface of the body and its consequent effects, varying according to the varying disposition of the individual. The tissue change and want of food are diminished, and while healthy persons feel disinclined to mental and bodily exertion, many weakly persons feel for a time like restored; irritation of the respiratory mucous membrane is allayed. In all persons there is a tendency to diarrhœa and affections of the abdominal organs. It must further be borne in mind that the combination of moisture and warmth favours the development of low organisms and sporules, and thus creates a source of danger. It is well known that in some moist and hot climates pulmonary consumption runs a rapidly deleterious course.

In *moist* and *cold* air the evaporation from the skin is diminished, but the surface loses much warmth by the clothing becoming damp, and thus acting as a better conductor of heat; rheumatic and catarrhal complaints are frequent effects of this constant chilling of the surface. While the functions of the skin are checked, those of the kidneys are called to increased labour, which under some circumstances leads to disease of these organs.

The influence of moisture of the soil we shall consider at a later place.

IV. ATMOSPHERIC PRESSURE.

The *weight of the air* varies at different places:—1, according to the degree of latitude; 2, according to the elevation above sea-level; 3, at the same place, according to the periods of the day and the year.

The knowledge of the distribution of atmospheric pressure over different parts of the globe, and during the different months of the year, as shown by isobaric lines, is of great value to meteorology, as the prevailing winds and the rainfall over the world to a great degree depend on the difference in the pressure of the air at different localities.

We do not yet precisely know how the comparatively small differences in the pressure influence the functions of man; more marked are the effects of the differences produced by elevation, but we postpone their discussion till we consider the mountain climates.

V. LIGHT.

It is impossible to doubt that light in its various qualities is a powerful factor in the complex agency of climate, but it is almost impossible to separate its influence on man from that of temperature and moisture. The facts that Chlorophyll is developed under the influence of light and that some plants cannot exist or flourish without light, and many similar experiences, point to the influence of this agent on organic functions. Moleschott has found that Batrachia under the same conditions of temperature exhale more carbonic acid when exposed to light than when deprived of it; and W. F. Edwards inferred from his experiments, likewise on Batrachia, that light is necessary to the development of the proportions of the body, belonging to the perfect type of the animal.

We constantly meet with persons who feel disinclined to work, and despondent as soon as the sun has been for some days invisible through clouds, or mists or fogs, and who rapidly regain their energy when the mist clears away. We have often seen these conditions of depression, which are mostly associated with digestive derangements, develope into a kind of home-sickness in natives of Switzerland, Piedmont, and Germany, living in this country.

VI. ATMOSPHERIC ELECTRICITY.

As we have little positive knowledge of the effects of light on the human body, so we are as yet to a great degree ignorant of the precise effects of atmospheric electricity on our functions, although we feel that they are very important, and that electrical conditions are intimately connected with what is called "bracing," and "relaxing."

VII. CIRCULATION OF THE ATMOSPHERE—WINDS.

Winds are the combined effect of changes in the temperature, moisture, and pressure of different parts of the atmosphere. The heavier air flows according to the law of gravitation to the region of lower pressure, or lighter air. We must refer for the details of the origin and laws of winds to the works of Halley, Dove, Mühry, and others, and confine ourselves to a rough sketch of a few points on some kinds of winds.

The most important currents owe their origin to the heating of the air in the tropics, in consequence of which it ascends to higher regions, and thence flows towards the poles, from which a lower current flows towards the equator. By the rotation of the earth from west to east, the direction of these winds is modified, so that in the northern hemisphere the main current blowing from the north is transformed into a north-eastern current, and in the southern hemisphere the main wind from the south becomes a south-eastern wind (trade winds); while the main current in the upper regions, flowing from south to north in the northern hemisphere appears as a south-west wind, and that from north to south in the southern hemisphere a north-west wind. From the meeting of the main currents flowing in opposite directions many intermediate winds result.

Local circumstances belonging to certain regions produce *local currents*, which are of great importance in the climatology of these parts. The best known are the so-called *land* and *sea breezes.* On most sea coasts a breeze from the sea towards the land sets in soon after sunrise; at first slight, it gradually increases in force, then in the afternoon, with diminishing heat, becoming slighter, it dies into a calm towards evening. After a short time, a breeze begins to arise from the land seaward, which gains in strength towards midnight, and subsides towards the morning. The causes of these breezes are, that during the day the land and the air above it become much more heated than the sea and the air resting on it. In consequence of being lighter, the land air ascends, and the heavier sea air flows towards the land to supply the deficit thus created. During the night, on the contrary, the sea and the air resting on it become much less rapidly cooled than the land and the strata of air above it; and thus the latter being heavier flows towards the sea.

By the unequal heating of land and sea during summer and winter *seasonal winds* are produced, which in some parts of the globe regularly recur with the seasons, as the *monsoons* in the Indian Ocean, which appear as south-west winds from April to the beginning of October, as north-east winds from then to April. Originally, the term "monsoon" was applied probably only to the ocean, now it is also used for the winds prevailing on the land in Southern Asia. Similar periodical winds prevail in Brazil, Peru, the southern parts of North America, and other regions. Their character and the periods of their distribution are always explainable by the distribution of atmospheric pressure, as shown by the isobaric lines of the different seasons.

A class of local winds prevailing in mountain districts important in the appreciation of health-resorts consists of the alternating currents from the slopes of *mountains* towards the lower parts of the *valleys*, and from the latter towards the higher parts of the valleys and up the mountains. There are many varieties in intensity and other characters, but the cause of their origin is much about the same—viz., that after sunrise the air in the valley and lower regions becoming heated ascends along the mountain sides and is felt as wind from the valley, and is, therefore, generally called *valley wind*, or *morning wind.* This ascending movement is in many localities aided by a kind of aspiration, owing to the air on the isolated mountain top becoming heated, and thus lighter. At and after sunset the air in contact with the summit and declivities of mountains becomes rapidly colder by contact with the surface cooled by radiation, and in consequence of its increased weight descends along the slopes towards the lower grounds of the valleys. Hence the term *mountain* wind—*i.e.*, wind from the mountain, or *evening* wind. Thus it occurs that under certain circumstances the lower regions are during the night colder than the slopes above them—especially the south and south-west slopes; and that the latter are more favourable positions for invalids and delicate plants than the bottoms of valleys.

In different countries there are many other local winds which bear different names. They have their origin often in distant regions, but are modified by local conditions. We will mention only some of them. The *Simoom*, or *Samum* (poisonous wind), is a very hot and dry wind arising from the deserts of Arabia and adjacent regions. The *Chamsin*, or *Khamsin* (fifty), is a similar hot and very dry wind, charged with minute particles of sand, blowing in Egypt in spring during about fifty days. The *Harmattan* is another desert wind, blowing over the Sahara towards Guinea and other parts of the west-coast of Africa, and extending as far as the Cape Verd Islands, withering the vegetation along its course. It blows with intermissions from the beginning of December to the end of February. The *Sirocco* is a hot wind which derives its heat from the Sahara, and is especially known by its depressing effect in Sicily and South Italy; but a wind of the same origin extends to Syria and Turkey, where the name *Samiel* is given to it. In Sicily and South Italy it is usually a moist wind, from having passed over the Mediterranean; and the same is still more the case at the Riviera di Ponente, where it appears as a south-east wind, and mostly is followed by rain; but in Syria, to which its way lies principally overland, it is a dry wind.

In Switzerland a wind known under the name *Föhn* is often mentioned, and greatly dreaded at some places. It shows its greatest force in the north-east Cantons of Switzerland, and is there a warm and generally a comparatively dry wind. It was formerly likewise regarded as arising from the Sahara, but Dove, Mühry, and Dufour have made it appear to be a modification of the equatorial current, having lost on its way from the Atlantic a great part of its moisture by condensation, especially on the western slopes of the Alps. The nature of the *Föhn* and its influence on different constitutions vary in different parts of Switzerland, because it is changed in its character on its way from one place to another by the height and temperature of the mountains which it has to cross, and by the state in which the mountains are—whether covered with snow and ice or with verdure. The *Föhn* is also different according to the way of its arrival—whether as an ascending or as a descending wind. It may be different at different times at the *same place*, not only from the conditions of the mountains which it crosses, but also because it was originally different. The south-west winds with us are sometimes more, sometimes less, laden with moisture; sometimes more, sometimes less, depressing or even exhilarating. The east wind differs likewise in its character at different seasons, and even in the same season. Why should not the *Föhn* be different too?

The Mediterranean region being much warmer in winter and spring than the regions to the north of it is, in consequence, exposed to cold winds from that direction. Hence, the *Bora* in the Adriatic region, and the *Mistral* of the Mediterranean coast of France, to which we shall return in speaking of the

Riviera, and which, during a period at least, appears to be, as Theodore Williams suggests, a modified general polar current.

Winds are an important element in climatology, as they produce rapid changes in temperature, moisture, atmospheric pressure, and light, and, so to speak, carry with them climates of distant regions. They are everywhere purifiers of the atmosphere, unless they convey special poisons to some distance. The study of the winds which prevail at a locality is essential before selecting that locality as a health-resort; and it is necessary to know not only how often and how long winds from certain directions blow at a given locality, but which are the prevailing winds at the different seasons of the year, and at different parts of the day, and what are the characters of these winds. The *name* of the wind is not enough, for a wind from the same direction—say an east wind—may at one locality bring intense dry heat, at another dry or moist cold, and at a third moist heat. And the same wind has often at the same locality very different characters during different seasons, because the conditions of the regions whence it comes and over which it blows are different.

Great Britain and its islands manifest the influences of various winds in very marked manner, and this is particularly the case with the south-west and the north-east winds. The south-west, which before reaching the British Islands has travelled over the Gulf Stream and the general equatorial current, has taken therefrom a large amount of warmth and moisture. It, therefore, brings to these islands in winter moist heat; and as the air of the land is cooler, part of the moisture becomes condensed into clouds and rain, a process by which a considerable amount of latent heat is liberated. By the prevalence of these winds, therefore, the winter temperature of these countries is materially raised. As the increased air moisture checks the radiation from the earth, the nights are rendered less cold, frosts are less frequent and severe, the fields remain green, and many evergreen plants of warmer regions flourish in the open air. In summer, on the other hand, these same south-west winds carry with themselves less heat than winds coming from the continents of Europe and Asia, because the surface of the Atlantic does not become equally hot as the continents. The south-west is, therefore, in summer a cool and moist wind; it lowers the summer heat, and produces a cloudy sky. Hence, it gives rise to splendid verdure, but prevents the ripening of fruit, which requires high and continued warmth. In short, the effect of prevailing south-west winds on the British Islands is a comparatively equable, somewhat humid, and dull climate. The east and north-east winds, which come over the north-east of Europe and the adjacent parts of Asia, where dry cold is usual in winter and early spring and dry heat in summer, carry these qualities, more or less modified, to Great Britain. Hence, when these winds prevail, we have cold and dry winters and springs, and hot and rather dry summers.

As to their influence on health, east winds in Great Britain, as a rule, are connected with a higher, west winds with a lower, mortality; but much depends on the force of winds and concomitant conditions of moisture and purity of air.

In general terms, it may be said that moderate winds only are conducive to the health of delicate persons; that high winds, especially when cold, are very injurious, as they increase the loss of heat, which delicate persons cannot supply without injury to other functions. Continual calms are likewise injurious, especially in great heat, and in localities where the air is impure.

General Considerations of Climate.

After having considered the different factors of climate, we must repeat that we have done this only in order to give some idea of the share of each factor in the whole product. In nature, however—viz., in the climate of a place—we can scarcely trace the action of any single factor, because the actions of all are constantly blended together in forming that subject of never-ceasing interest—the *weather;* and the nature of the weather—which a certain region or a certain restricted locality of a region enjoys during a series of years—seasons, months, days, and periods of day, forms the climatic character of a region or locality.

We must once more before considering different climates glance at some conditions which more or less influence all climates, and produce deviations from the solar climate. We have already discussed the *unequal distribution* of *land* and *water* as one of the principal causes of deviation; especially the influence of the sea, with its warm and cold currents, and that of large inland lakes.

Extensive Continents produce effects almost opposite to those of the sea. In summer they become excessively heated; in winter, in higher latitudes, excessively cooled. In consequence of this, in the north-east of Europe and in the adjacent part of Asia, large centres of cold and high atmospheric pressure are formed, from which cold winds flow towards the regions of lower pressure. The cold north-east winds prevailing in the British Islands, and more or less in the whole of western and central Europe, are due to this circumstance. In summer, on the contrary, the air pressure in the north and centre of Asia is low, and, in consequence, the air from all sides flows in that direction, giving rise in Great Britain and western Europe to the cool south-west and west winds. Thus these large continents exercise a marked influence on very distant regions. Extensive continents in the neighbourhood of the tropics become very hot during the day under the sun's influence, and often very cool during the night. Wind blowing over these regions carries to adjacent countries hot and dry air, as exemplified by the desert of Sahara, and, to a lesser degree, by the continent of Australia.

Extensive plains show in general great differences between the heat of the day and the cold of the night.

Hilly districts become unequally warmed under the influence of the sun, by which local currents are produced, with changes in temperature and moisture. Their climate is, as a rule, less extreme than that of extensive plains.

Mountain chains produce different effects, according to height, extension, direction, quality and degree of vegetation, greater or less abruptness, &c. We have already mentioned that they may act as barriers to cold or warm winds, and thus cause in the former case higher annual temperatures in the localities to the leeward; in the latter, lower. They exercise, however, also an immediate action on the winds themselves, and especially on moisture-laden warm winds, by depriving them, through condensation, of a considerable portion of their moisture, while the moist winds cross the chain. The climate of regions to the leeward of the chain thus becomes drier and less equable ; it has hotter summers and colder winters, and the difference between the extremes of temperature is greater. To some degree we see this in the British Islands, by comparing stations on the west coast of Ireland with others on the east coast of England ; but the difference is much greater in Norway between the leeside of the Dovre Fjeld mountains (Dofrines) and the wind side.

The influence of the *surface* on the temperature and humidity of the lower strata of air is somewhat complicated. As to the relation of the surface to sun-warmth, Dr. Frankland's experiments show that snow is the best reflector, and that other surfaces succeed in the following series:—Light-coloured soil, parched grass, grey rock, green grass ; and that their absorbent powers for sun-warmth are in the inverse ratio; or, in other words, that the best reflectors are the worst absorbers of heat, and *vice versa.* The nearer the colour of the ground approaches to white, the greater will be the sun-warmth and the cooler the air ; while the darker the colour, the warmer will be the air, and the less will the heat of solar radiation be felt.

The absorbing power for moisture differs even more than that for temperature ; thus Professor Elliot showed that peat-moss absorbs more than twice its own weight of water, dry clay about its own weight, dry garden mould half its weight, dry sand rather more than one-third. Sand dries most quickly, peat-moss most slowly.

Buchan gives interesting facts on the *effect of drainage on the temperature of the soil.* 1. The mean temperature of arable land is raised nearly one degree, (0°·8) Fahr. by drainage; 2, during sudden falls of temperature and protracted cold weather, the cold passes more quickly through undrained than through drained land; 3, when the temperature of the air is higher than that of the soil, drained land loses less heat by evaporation than undrained land; 4, the temperature of drained land is more equable than that of undrained land, the superfluous moisture flowing off rapidly from drained land ; 5, the temperature of drained land is in summer often raised 1°·5 to 3° above undrained land. These facts throw some light on the important experiences of Bowditch and Buchanan relating to the influence of drainage on the diminution of phthisis.

The absence or presence of vegetation exercises in all climates a marked influence on some of the factors of climate. Bare surfaces differ in their effects on the air according as the nature of the ground is a better or worse conductor. The covering of the surface by vegetation prevents more or less completely the direct striking of the sun's rays on the ground itself, and thus protects it from being heated to the same degree as dry sand or bare rock, and the plants themselves are never heated quite so much on account of the constant process of evaporation. The nature of the vegetable covering produces, however, considerable differences, according as it consists of forests, grass, heather, peat, or marsh.

The influence exercised by *forests* has been specially studied by Professor

Ebermayer.* He found the annual temperature of the ground itself on which the forest stands several degrees lower than that of the neighbourhood, an influence which extends to the depth of four feet, is greatest in summer, and least marked in winter. The air within the forest has a rather lower annual mean. In summer the cooling influence is especially marked during the day and during sunshine. The changes of temperature in forests are less rapid, and altogether forests have a more equable climate, cooler days and warmer nights; the difference between the maxima and minima being decidedly smaller. Equally important are the conditions of *humidity.* Ebermayer found the relative humidity always higher in forests—in July about 10 degrees, and in January about 3·7 degrees. There can further be no doubt that forests lead to increased rainfall. This is easily explained by the circumstance that the air in forests is cooler and more saturated; if, therefore, a moist wind reaches the forest the vapour is condensed into mist and rain. Another characteristic of forests is that there is less movement of air, that winds are to some degree checked by them, and that this influence extends to some distance on the leeward side of the forest. In some localities this point is of special importance, in keeping off cold currents of air. Thus it is a matter of general experience with gardeners that woods on the slopes of hills form a protection to delicate plants and shrubs grown at a certain distance below the woods, that shrubs so situated will often during cold nights remain unhurt, while the same kind of shrubs situated on the same level without a protecting wood on the slope perish from frost.

Under *grass-land* we comprise, for the sake of brevity, fields covered with grass, clover, and other short green plants standing close together. As already mentioned, such surfaces never become so hot under the sun's rays as light-coloured, bare surfaces. The difference of temperature of the air strata above barren sand and green fields is sometimes very great: we have ourselves found twenty and thirty degrees. In general terms we may say that grass-land tends to diminish the summer temperature, and to render the air moister.

Peat and *marsh-land* is characterised by dampness of soil and humidity of atmosphere, and comparatively low annual temperature; the surface is often covered with mist. Marsh-land, in addition, is apt to give rise to malaria, which, we must remember, may be carried to more or less distant localities according to the direction of the wind and the configuration of the ground.

DIVISION OF CLIMATES.

Every classification of climates must be arbitrary and imperfect; and most writers on climate have different arrangements. The division according to the *degrees of latitude* would be the most easy, but the same degrees of latitude may contain the most different climates.

The divisions according to the *mean annual temperature* adopted, with various modifications, by some of the most distinguished French authors, as MM. Lévy, Rochard, Fonssangrives, and Lacassagne, possess greater advantages, as the temperature of the air is one of the most powerful elements of climate as it affects man. The value of the *annual temperature*, however, is very limited in the *treatment* of disease, because it does not show the distribution of temperature amongst the different periods of the year. Climates with an annual temperature between 48° and 52° Fahr. may include localities with mild winters and cool summers, and localities with very cold winters and hot summers.

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* "Die Physicalischen Einwirtkungen des Waldes auf Luft und Boden." 1873.

Torquay, Paris, and Odessa have nearly the same annual temperatures—viz., Torquay about 52°, Paris about 51°·5, and Odessa about 50°·4, Fahr.

	Winter.	Spring.	Summer.	Autumn.
Torquay	44°·0	50°·1	61°·3	53°·1
Paris	38°·4	50°·4	64°·5	52°·0
Odessa	27°·5	45°·8	70°·0	50°·7

The difference between summer and winter is for Torquay about 17°, Paris 26°, Odessa 42°·5; and it would not be difficult to give many much more striking instances.

A division according to the temperatures in the different seasons would be somewhat more useful, because invalids spend only certain seasons at certain health-resorts; but this, too, would be very imperfect, as climates with the same winter temperatures show great differences in the variations of temperature on different days and at different periods of the same day. Moreover, classification, according to temperature, does not take into account the *humidity* of the climate, and the conditions depending on the latter.

Several English and German authors justly value the great importance of the *relative humidity;* we need only point to publications of Vivenot, Walshe, Rohden, C. T. Williams, P. Niemeyer, Thomas, and Biermann. In the paragraphs on humidity of the air as a climatic element, we have pointed out its intimate relation to equability and variations of temperature, diathermancy and transparency of the air, light, electricity, ozone, and evaporating power—by all of which, directly and indirectly, the organism is much influenced. Thomas, therefore, proposes to make the relative humidity the main principle of classification, but other climatic factors would, we fear, not be sufficiently appreciated in this way.

Every kind of classification appears to us so constrained that we should be inclined to give up all attempts at it, and treat the different places alphabetically, but this would lead to frequent repetition and would require much space. We will, therefore, follow the plan, though it be an imperfect one, which we have adopted in a previous communication on the subject,* to divide the different climates used as health-resorts into large groups, suggested by geographic-physical conditions, and sub-divide them according to prominent climatic features.

The influence of the sea is so powerful that we adopt two great divisions:—
A. Marine climates (Island and coast climates). B. Inland climates.

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* "Klimatotherapie" in Ziemssen's "Handbuch dir allgemeinen Therapie", Vol. II. Part I., 1880.

A. Marine Climates (Island and Coast Climates).

Perfect sea or marine climates exist only on the high seas, and can therefore be enjoyed only on sea voyages. These have been mentioned in the article on Travelling, and we shall consider in this division only islands of moderate size, which are under the full influence of sea air, and sea coasts which are likewise powerfully influenced by the sea, although the nature of the adjacent lands has a great share in their climates. There are considerable differences between the localities comprised in this division, according to the distance from the equator, the sea currents to which they are exposed, and also the land currents; but they have many points in common.

1. The air is, as a rule, more free from organic and inorganic dust than in inland regions.

2. Sea air contains a comparatively large amount of moisture, owing to the constant and abundant evaporation from the surface of the sea, and the amount of moisture varies less than in continental climates.

3. There is greater *equability of temperature* than in continental climates, as well with regard to the difference between summer and winter as also between day and night, and the various parts of the same day. The winters are not so cold, because the sea remains warmer in winter, and warms the shore by contact as well as by the currents of wind, and because the radiation, which is very great during winter on continents, is somewhat checked in marine climates by the large amount of moisture in the air. To the increased humidity is also due the greater equability between day and night, and during the different hours of the day.

A striking instance of this equability of a perfect sea climate is given by Alexander Buchan in his suggestive article, "Climate," in the "Encyclopædia Britannica"* in the island of *Monach*, situated about seven miles westward of the Hebrides, between 57° and 58° N.L., "in the full sweep of the westerly winds of the Atlantic which there prevail. The mean January temperature is 43°·4, being 1°·8 higher than the mean of January at Ventnor, Isle of Wight (nearly seven degrees further south), 0°·8 higher than that of Jersey and Guernsey, and almost as high as that of Truro." On the other hand, the mean temperature of July is 55°·0 at Monach, and 62°·6 at Ventnor. "Thus the conditions of temperature at these stations are completely reversed in summer, for while in January Monach is 1·8° warmer than Ventnor, in summer it is 7°·6 colder."

The influence of sea air, or rather change to the sea-side, on the constitution varies considerably in different persons and in different localities; but as a rule we may say that tolerably healthy persons perceive increase of appetite, increase of tissue change, greater mental and bodily energy, and sounder and longer sleep; and in cases of general weakness without disease, improvement in sanguification, muscular and nerve power, and in the condition of the skin, and in consequence diminished liability to catarrhal and rheumatic affections. These climates are very useful in the numerous cases of weakness without actual development of local disease; during convalescence from disease; and in many climacteric conditions. They are invaluable in the physical training of children with a tendency to scrofulous or tubercular diseases and their allies. A certain degree of power of resistance, however, is necessary, and tolerably healthy organs of digestion and assimilation. In some forms of weakness of the heart with a tendency to passive congestion in the liver and other organs, sea climates often disagree; and in serious affections of the heart they ought to be avoided, as also in some kinds of asthma and skin affections.

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* Vol. VI. 1877.

The numerous varieties in the climatic conditions of the different marine localities render it necessary for us to form sub-divisions; and here we are again met by great difficulties.

Some islands even of limited size possess different climates in different parts, and comparatively small bays exhibit very different conditions, as well on the sea-level itself according to aspect and exposure as also and even more in the different elevations of the rising shores; nay, in the same locality different parts are climatically so different that they might be ranged in different climatic groups.

As the *humidity* of the air exercises great influence on the equability of climates and on many functions of the body, we will adopt it with C. T. Williams, Biermann, Thomas, and others as the principle of the greater sub-divisions, and use the differences in temperature in the formation of sub-classes.

In adopting the three sub-divisions—I. Humid marine climates; II. Marine climates with mean humidity; III. Dry marine climates—we must, however confess that no clear line of demarcation can be drawn—that some localities might be placed with almost equal reason in the class before or after that in which we put it.

I. Humid Marine Climates.

There are great differences in this class, according to the prevailing temperatures. Among the *warm* and *humid* marine climates *Madeira* may be selected as the representative. It was in former years regarded as by far the best climate in the treatment of consumption, and has, of late, been repeatedly described as the very worst. We will endeavour to give a short, impartial description, and refer for ampler information to the works of Heineken, Renton, Clark, Mittermaier, Lund, Grabham, Goldschmidt, and others. The Madeira islands are situated between 32° and 34° N.L., and between 16° and 17° W.L. *Funchal,* the principal place, is the main health-resort, but a few hill stations are likewise occasionally employed. The climate of Funchal is remarkably equable—more so, probably, than that of any other health-resort. The annual temperature is about 65°, the lowest night temperature scarcely ever below 48°, the highest day temperature rarely above 86°; mean winter about 61°; spring, 62°; summer, 69°·5; autumn, 67°. The mean differences between day and night about 9°, from one day to another about 1°·1. The atmospheric moisture is considerable, averaging about 70° to 74°, but is subject to great changes under the influence of different air currents. The number of rainy days is generally above fifty. Funchal is not exempt from winds—they are even sometimes violent; but the air is generally calm from 7 to 9 A.M.; this period is usually followed by sea breezes, which last till 8 or 9 P.M.; and late at night the land wind sets in. A disadvantage of Funchal is the difficulty of getting out of the region of houses on foot, on account of the steepness of ascent. The air however, is free from mineral dust, and rich in ozone. The character of the climate is *sedative*, and to many persons *relaxing*. Great is the power to allay cough in persons affected with irritability of the respiratory mucous membrane; but after some residence many invalids perceive loss of appetite and tendency to diarrhœa. The effect of Madeira in consumption has been, no doubt, in former years too much extolled, and of late too much depreciated. The result of the experiment made on twenty selected cases of the Brompton Hospital has not been quite satisfactory. In incipient disease, when it occurs in erethic subjects, and when it has been ascertained that sea voyages are well borne, that the great distance from home does not act unfavourably, that comfort and warmth are necessities to the invalid, that the beauty of a sub-tropical vegetation has an exhilarating effect, and that there is no tendency to diarrhœa, a trial deserves to be made. The charm of Madeira is to some persons so great that it is impossible to dissuade them from going there; they feel new life, they say, immediately after arriving in the island, and will rather live and even die there than anywhere else. More generally beneficial than in phthisis is the climate in cases of chronic catarrh of the larynx and bronchi, and in emphysema with scanty expectoration. Madeira under such circumstances especially deserves recommendation if the circulation and the power of keeping warm is feeble, and if, further, the circumstances just named under phthisis exist. On the other hand, in all conditions of relaxation of the system, with tendency to copious discharges from the mucous membrane, and in atomic dyspepsia, Madeira and allied climates ought to be avoided.

The *Azores*, a volcanic group of islands, between 36°·59′ and 39°·54′ N.L., and 31°·7′ and 25°·1′ of W.L., have similar climates to Madeira.

St. Michael's, with *Ponta Delgata* as chief town, and *Villa Franca* more pleasantly situated about fifteen miles to the east of the former, have a soil of light pumice-stone covering the lava, which affords dryness at foot, even after the heaviest rains, in spite of the moisture of the air. *Fayal*, with the town of *Horta*, has many English and American residents.

The *Canaries*, a few degrees nearer the equator, have a somewhat higher temperature—viz., an annual mean of 70°, but the character of the climate is otherwise similar. *Teneriffe*, the principal island, is the only one which offers accommodation to the invalid, but this is very limited at *Santa Cruz*, the capital, while it is somewhat better at *Orotava*, a town on the north-western side of the island. The temperature of the latter place is several degrees lower than at Santa Cruz, and scarcely differs from that at Madeira. Some friends of ours who spent several years at Orotava describe the climate and the country as delightful, and went during the summer to higher elevations, by which they escaped inconvenience from heat, which otherwise was well suited to their feeble circulations and chilly natures. The Pic de Teneriffe would probably offer some sites for the erection of sanitaria; it is here that W. Marcet made his experiments on the expiration of carbonic acid. (Proc. Roy. Soc., 1879.)

The *Southern Hemisphere*, where the sea predominates more than in the northern, possesses some island groups with a warm and moist climate, which may some day become climatic health-resorts.

The *Friendly* or *Tonga Islands*, between 18° and 23° S. L., and 173° and 176° W. L., have a remarkably mild and equable climate.

The *Feejee* (Fidji, Fiji, or Viti) *Islands*, a volcanic group between 15° and 19° S. L. and 177° and 188° W., are described by a gentleman who has repeatedly resided for several months in *Ovolau*, one of the largest and most beautiful of the group, as warm and tolerably equable, ranging between 62° and 95°, and fairly healthy. Fresh trade winds from the east between April and November, and frequent north winds from December to March, with occasional gales.

The *Society Islands*, between 16° and 17°·5 S. L., and 148° to 151° W., are all mountainous. In *Tahiti*, the largest island, with mountains rising to 6,000 and 8,500 ft., localities of great beauty and of healthful climate are described, with an annual temperature between 70° and 74°, ranging between 64° in the coldest and 79° in the hottest season, and a relative moisture between 80° and 90°. Considering the different degrees of elevation, these islands may be regarded as health-resorts of the future.

The group of *Tristan-D'Acunha*, between 37° and 38° S. L., and 12° and 13° W., with a volcanic mountain of over 5,000 ft. in the largest island, is said to possess a remarkably equable climate, cooler and less relaxing than the Feejee and Tonga groups. Two gentlemen who removed there on account of chronic bronchial affections, contracted in Victoria, enjoyed excellent general health during a stay of several months, and recovered completely from the bronchial affection.

St. Helena, between 15° and 16° S. L. and 58°·4′ W., a volcanic island with an annual mean of about 66° Fahr., is a useful climate as a change from hotter regions, but has not been found beneficial in phthisis.

Cool and *humid* marine climates are rarely used in the climatic treatment of disease, but they are meteorologically very interesting by their great equability of temperature. The most characteristic and best known localities belonging to Europe are the *Hebrides*, the *Orkney* and *Shetland Islands*, the *Faroe Islands*, and *Iceland;* and in the southern hemisphere, the *Auckland Islands* and the *Falkland Islands.* Mr. Buchan's article on "Climate," in the "Encyclopædia Britannica," which we have already quoted, contains instructive remarks on this class of climate.

II. Marine Climates with Mean Humidity.

In this sub-class we have to deal with *warmer* and *cooler* localities.

Amongst the *warmer*, *Mogador*, on the north-west coast of Africa, in Morocco, is one of the most equable: mean annual temperature, 67° Fahr.; mean of the hottest month, 80° Fahr.; mean of the coolest month, 59° Fahr.; mean winter temperature, about 61° Fahr.; mean summer temperature, about 72° Fahr.; mean relative humidity, 78°. The number of rainy days is about 44, that of clear days 270. There are only occasional morning fogs; the desert wind is rare, owing to the shelter afforded by the great Atlas chain, and from the situation it is clear that Mogador is under the influence of the Atlantic. The late Dr. Leared described it as healthy, and much cleaner than other seaports of Africa and many of Europe. The accommodation is limited, and the surrounding country not interesting.

To this warmer group belong several of the health-resorts on the shores of the *Mediterranean*, which, though situated on different continents and contiguous to widely different climatic regions, have much in common, owing to the powerful influence of the Mediterranean Sea. They possess comparatively high temperatures with only moderate variations, and more or less rainless summers, abundant autumnal rains, and in some places also winter rains. The high temperature is caused both by the warmth of the Mediterranean, which, as we have pointed out before, is greater than that of the Atlantic, and extends to the very bottom, and by sheltering mountain chains. The western portion has a more oceanic character than the eastern. The humidity of the air is moderate, the evaporating power considerable. Everywhere the humidity varies during different periods of the day, especially on clear days, when towards sunset sudden changes occur, which demand, on the part of the invalid, great caution. A portion of the shore is so much drier than the rest that we shall place it under the dry marine climates.

Tangiers in Morocco, only 35 miles from Gibraltar, has, according to Leared (*Lancet*, 1873), a mild, bright, and tolerably equable climate, with moderate humidity; approaching, however, more the humid than the dry class, from its exposure to the Atlantic winds as well as to the Mediterranean; while the hot and dry desert winds are checked by the intervening mountains. The amount of rain is not large, and falls principally in November and December, while the sky during winter and spring is generally clear. The mean winter temperature is between 57° and 62°. Leared and most of those who have resided at Tangiers describe the climate as delightful, and the immediate neighbourhood as interesting, and speak well of the principal hotel; but the main thoroughfare and the narrow lanes are filthy, and there are as yet no good and secure roads to any distance.

Algiers consists of the old Moorish town with the French settlement and the better situated suburbs, of which *Mustapha Supérieuze* is the most eligible locality for invalids. The climate of Algiers seems to vary considerably; hence, some call it very damp, others rather dry. The number of rainy days varies between 45 and 65 during the six months forming the invalid's season—viz., from the end of October to the end of April, and the mean temperature is variously stated between 57° and 62°. About the relative humidity we have no exact knowledge, but the rich green of the hills, which has procured for it the name of "pearl set in emeralds," sufficiently indicates the rather humid character of the air. It seems in this respect intermediate between Egypt and Madeira. The north-west is the prominent wind, and is sometimes very strong. The sirocco is rare during winter, but is, when it blows, hot, sultry, and dry, carrying with it the fine sand of the desert. In cases of incipient phthisis, and in protracted recovery from pneumonia and pleurisy, the climate is generally beneficial under proper management; in affections of the kidneys and liver, and in persons inclined to bilious attacks it is not to be recommended. The presence of good physicians—English, French, and German—is an advantage; but the sea voyage of forty hours is to many persons a drawback.

Cadiz, on the island of Leon, on the south-west coast of Spain, partakes of the character of the Atlantic as well as of the Mediterranean; has nearly 100 rainy days in the year, and an average relative humidity between 76° and 80°; the mean winter and spring temperature is about 59°, and the average daily range only 10°·5.

San Lucar, at the mouth of the Guadalquivir, with a somewhat drier climate, is recommended by Spanish physicians in commencing phthisis.

Gibraltar is allied to these localities by its conditions of temperature and humidity.

Valencia, the ancient *Valencia Edetanorum* originally founded by Junius Brutus, is an important and interesting town, but its mild and equable climate is marred by the irrigations of adjacent rice-fields, and has had an unsatisfactory influence in several cases of early phthisis which have come under our notice.

Ajaccio, on a bay facing south-west, in the island of Corsica, has a mean temperature of about 54° in winter, and 59° in spring, with moderate daily ranges; about 35 days of rain during the two seasons named, and according to Valentiner a mean humidity of 80°. It is favoured with rich vegetation, a large number of bright days, absence of mineral dust and of mosquitoes. It is sheltered from cold winds, but exposed to south-west. The accommodation is fair, and the general health of the inhabitants is good.

The island of *Sicily* has, in many respects, an insular climate, but the hot sirocco coming over the Sahara brings to it occasionally unwholesome messages from the African continent; on the east coast it appears as a south-east wind, is often very violent, but not very dry, while at Palermo and on the greater parts of the north coast it is rather dry, hot, and scorching, irritating, and depressing. Rain falls rarely in summer, but abundantly in late autumn and winter. The mean humidity is somewhat higher at Palermo and the north coast than at Catania, Acireale, and Syracuse, the latter thus approaching the dry localities.

Palermo, with its beautiful situation, rich in antiquities, and with the charms of sub-tropical vegetation, has a mean temperature of about 53°·5 in winter, and 59° in spring, a mean daily range of about 10°·5. The usual winds are from north and east, and are in spring sometimes strong. The accommodation is good, and invalids without active disease, who require principally light and warmth, mostly derive great benefit; but to those requiring delicate management and shelter from winds Palermo is not suited.

Catania, on the eastern coast of Sicily, and, as it were, under the shade of Etna, has a mean temperature of 53°·8 in winter, and of 60°·5 in spring, with a mean daily range of 14°·5. The humidity is somewhat lower, and the daily and annual changes of temperature rather greater, than at Palermo.

Acireale on the rail from Messina to Catania, scarcely ten miles to the north of the latter place, somewhat nearer to Etna, about 560 feet above sea-level, built on different lava streams, has a climate very similar to Catania, but has to invalids in want of pure air the advantage of being a smaller town (only about 24,000 inhabitants). It possesses a good new hotel, with views of the sea and of Mount Etna.

Syracuse, on the island of Ortygia, will be for ever one of the most interesting places to the lover of classical antiquity; it is not, however, an eligible health-resort to those requiring shelter.

In this group we may mention the localities situated on the *Riviera di Levante and its neighbourhood.* They all have a medium humidity, approaching rather the dry than the humid maritime climates. *Viarregio, Spezia, Chiavari, Rapallo, Santa Margherita, and Nervi* have all a larger annual rainfall than the localities on the Riviera di Ponente, a somewhat higher relative humidity, and rather analogous conditions of temperature; they are not quite so well sheltered from the cold winds, because the surrounding mountain chains are less high, and have gaps. The principal inns are too far away from the sheltering mountains.

Pisa does not lie close to the sea now, as it did in former times. The marine character is somewhat modified by being a few miles inland, the climate being less stimulating and the air less moved by the daily sea and land currents. It was formerly a rather celebrated health-resort, the air having been described as remarkably calm, and the temperature as specially equable, but it does not quite deserve these praises; the air is frequently dull and misty when it is clear at both Rivieras, where, in addition, natural beauty and vegetation are so much more attractive.

Viarregio enjoys an increasing reputation as a sea-bathing place, and has of late been used as a winter resort also. The immediate neighbourhood of large pine woods (Pinetas) offering shade and shelter is a peculiar advantage; but, as at Pisa, mists are not quite rare.

Spezia has the most beautiful situation of the health-resorts on the Eastern Riviera. The view over the bay is magnificent, and the walks in the neighbourhood are fine; but they are only for the hardier class of invalids, while those requiring much shelter must look for other quarters. Two good hotels belong to the attractions of Spezia.

Nervi is much more sheltered, especially towards the north and fairly towards the east, but less so from north-east and north-west. The walks are rather limited by the steepness of the mountains and the scantiness of good roads. The climate is mild, as the abundant sub-tropical vegetation shows; and although the number of rainy days is large, the climate cannot be called humid.

The whole coast between Nervi and *Rapallo* contains many eligible situations for those who do not require much shelter, viz., *Bogliasco, Sori, Recco, Camogli;* and tolerable shelter extends also over part of the road from Nervi to Genoa, viz. to *Quinto* and *Quarto;* while further on the very uncertain character of Genoa begins to be felt, so that it may rain at Quarto and snow at Sturla, the next station, less than a mile distant.

Genoa itself and its immediate neighbourhood are changeable, windy, and rainy; but *Pegli*, about six or seven miles from Genoa, in the direction of the Western Riviera, offers a much more equable and sheltered climate. Pegli is generally regarded as belonging to the Western Riviera, but it has more rain, a somewhat greater relative humidity, and slightly greater range of temperature; it shares, in fact, to some degree, though not completely, the raininess without the windiness of the Gulf of Genoa. The neighbourhood is very attractive; it offers delightful walks in the pine-woods and amongst the hills, clothed with pines and magnificent old tree-like shrubs of the Mediterranean heath. Most cases of laryngeal irritation and many forms of asthma are benefited, and, not rarely, persons affected with nervous irritability who have not borne Cannes and Nice or Mentone. Pegli forms also a good transitory station in spring from the Western Riviera to the Italian or Swiss lakes. It would be an advantage if the inns were further removed from the public road and life of the natives.

Very different from the group of the Eastern Riviera is that of the *Adriatic Sea*, which is characterised by the prevalence of two opposite winds, viz., the *Bora*, a dry and cold wind from the north, and the *Sirocco*, a sea wind from the south, which in this region is not a dry but a moist wind. The best-known locality in this group is *Venice*, on the north-western shores of the Adriatic, which in former years enjoyed a great reputation in phthisis—a reputation which experience has not fully substantiated. The temperature is several degrees lower than at the Rivieras; the humidity is greater. The mountains to north, north-east, and north-west do not offer complete shelter against the north wind (*Bora*), which occasionally sweeps down from over the mountains like a cold blast, chilling unprepared delicate invalids to the very marrow. Besides this, the limited room for exercise becomes tedious, and induces people to visit the tempting but sunless and often cold and damp churches and galleries. Interesting as Venice is for healthy persons, it is unsuitable for the majority of invalids, amongst whom there are only very few who are able to govern themselves. The absence of dust and malaria is no doubt a great advantage, and on fair days the walks on the Schiavone and the Piazza of St. Mark are unsurpassed. Cases of chronic arrested phthisis with tendency to irritable cough, some forms of irritability of the nervous system with sleeplessness, may, therefore, be recommended to Venice, especially in March and April, when other places have likewise great defects. The Riva degli Schiavoni is the best locality for invalids.

The island of *Lesina* (43°·11′ N.L.) has been favourably described by Professor Ungar,[*] who maintains that the chalk hills to the north of the town of Lesina shelter it from the *Bora*. The temperature in winter is similar to that of the Riviera di Ponente, but the place is windy. The humidity is less than in other localities of this group, probably from the absence of wood. The abundance of lemons, oranges, figs, and wine points to a high degree of summer heat. The accommodation is, as yet, scarcely sufficient—a remark which applies also to the neighbouring island *Lissa*.

Corfu, at the entrance of the Ionian Sea, has a most beautiful situation, and is compared by H. Reimer,[†] in his very useful work on winter health-resorts, with Naples, not only with regard to the charms of its situation, but also with regard to the inconstancy of its winter climate. The winter is warm, exceeding 50° Fahr. even in January and February, and reaching 60° as early as April. The humidity is rather considerable; winter being the rainy season, with over 72 rainy days between November and April; the mean relative humidity varies between

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[*] "Wiener Med. Wochenschrift," 1868.

[†] "Klimatische Winter Kurorte." Von Hermann Reimer, 3rd Edition. Berlin, 1881.

70° and 80°. Corfu is by no means sufficiently sheltered from winds, which sometimes suddenly turn from the dry and cold north to the warm and moist south. *Hennen** says of the climate :—"It is extremely variable at all times, and at the best infinitely inferior to that of the healthy part of the continent of Italy." Corfu, with all its beauty, is, therefore, no climate for delicate invalids; and even hardier ones must exercise the greatest vigilance.

Zante and *Patras*, which are likewise occasionally recommended, are not less uncertain. *Hennen* says of Zante: "In winter the climate is extremely variable and wet; in summer the heat is very oppressive."†

The *Crimea*, *Cyprus*, and the *Coasts of Asia Minor* offer localities which climatically would be available as health-resorts during certain seasons of the year, but the hygienic conditions and the accommodation are not yet satisfactory.

The *Western Coast of the Iberian Peninsula* possesses at present not a single place which can be recommended as a climatic resort to invalids, with any degree of confidence.

Lisbon enjoyed at one time a considerable reputation, but although the mean temperature in winter and spring (51° and 59° Fahr.) and the mean relative humidity (70° and 80°) would appear satisfactory, and the number of rainy days in the year is rather excessive (about 110), the changes from warm to cold, from humid to dry, are so rapid and so frequent, and the winds so treacherous, that the climate must be called dangerous to invalids. The same remarks are more or less due to other localities, full of natural attractions, as *Vigo*, *Corunna*, *Ferrol*, *Santander*, *San Sebastian*, and *Portugalete.* These places are of great local value for sea-bathing and change of climate and scenery, but their advantages are not so great as to recommend them to inhabitants of distant countries.

The *South-west Coast of France* possesses several localities which are more easily accessible from England, and offer somewhat greater advantages than the west and north-west coasts of Portugal and Spain.

Biarritz (43° N.L.) is under the full influence of the Atlantic, and is exposed to the prevailing winds without any shelter; it is bright and bracing to most persons, in spite of its rather high relative humidity. There is much rain, but the dry soil rapidly absorbs it, and the air is rarely felt to be damp. Biarritz, with its excellent hotels, is principally used as a summer resort for its air and bathing by French and Spaniards, but it is very suitable in autumn and spring to those requiring no special protection. Persons disposed to hypochondriasis and mental depression, and many old Indians, with their somewhat complicated cachexia, without organic disease, derive great benefit from the cheering influences of this climate, which is also a very good change from Pau and Arcachon; and Dr. Frank and other physicians of the Western Riviera often avail themselves of the ready communication by rail to make their patients escape from the Mistral and from the rather irritating influence of their climate in cases of irritability of the nervous system or tendency to hysteria.

St. Jean de Luz, a little to the south of Biarritz, lies on a beautiful bay, and has a similar climate, with perhaps a little more shelter, and a more interesting neighbourhood from its nearness to the Western Pyrenees; but the accommodation is as yet much inferior to that at Biarritz.

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* "Medical Topography of the Mediterranean." By John Hennen, M.D., F.R.G.S. London, 1830 (p. 153).

† *loc. cit.*, p. 311.

Very different from these two places, yet allied to them by the influence of the Atlantic, is *Arcachon*, about nine or ten miles away from the actual shores of the sea, and near a large basin of salt water united with the sea by a narrow channel. The principal peculiarity of Arcachon is that it lies within a large pine-forest, which is spread over the extensive sand-hills, or dunes, of the Atlantic. Dr. Burney Yeo justly points out in his instructive book on health-resorts*, that it is "protected to a great extent from the fury of the west and south-west winds by the dense forest, which also offers a protection from the winds coming from the east and south-east." To the north and north-east lies the great basin; and "the north and north-east winds must pass over this basin, and become thus somewhat warmed in winter, and their irritating dryness diminished." The climate is tolerably equable; the annual temperature, according to Hameau,† about 58°; relative moisture about 85°; days of rain 103; amount of rain 32 inches. In spite of the large number of rainy days the soil is always dry owing to its perfect porosity. The action of the large masses of pine-leaves on the air, though its nature is not yet clearly defined, is no doubt very important, and the houses in the "*ville d' hiver*" are all situated in the midst of the forest. According to Dr. Hameau, whose experience is fully confirmed by the intelligent English clergyman (Rev. Samuel Radcliff), cured there from a chronic pulmonary affection, and quite accords with Dr. B. Yeo's views, "the climate is mild and soothing, and is especially suitable to cases of irritable bronchial or laryngeal catarrh, to cases of phthisis with tendency to congestion or inflammatory complications, and to persons of nervous temperament." "It is not suited to persons of a lymphatic and torpid habit" (*loc. cit.*, p. 262). The best season for Arcachon we should say is from October to April or May.

The *Southern Hemisphere* contains some good climatic regions belonging to this group.

New Zealand is known to be one of the most healthy parts of the earth, and, as already remarked by Dieffenbach with regard to climate, resembles England more than any other country; but it is obvious that great differences must exist, as it extends over thirteen degrees of latitude (34° to 47° S. L.) with long coast lines towards east and west, with some plains, but many hills covered with forests and mountains exceeding in several places the perpetual snow-line. The coasts of New Zealand are much exposed to winds, which are sometimes violent. The rainfall is considerable—30 to 50 inches and more; but the number of dry days is nevertheless much greater than in England. The climates of New Zealand may be called temperate, equable, and rather humid; those of the northern island belonging to the warmer group, those of the middle island to the cooler, and those of the small southern island still more so.

New Plymouth, *Wellington*, and *Nelson* have probably the most healthy climates among the larger towns. The health of the colonists is described as satisfactory, but with a tendency to rheumatic troubles. We are acquainted with a certain number of cases in which by migration to these localities and an open-air life, phthisis in early stages has been checked. Dove gives in his temperature-tables the following figures for Auckland (about 36° N.L.): Annual 58°·58; winter, 50°·75; spring, 56°·83; summer, 66°·92; autumn, 59°·83. The difference between the coldest and hottest season is, therefore, 16°·17, and this is probably about the average difference in the other towns.

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* "Health-Resorts and Their Uses," p. 261. Chapman and Hall, 1882.

† "The Climate of Arcachon." By Dr. G. Hameau. Translated by the Rev. Samuel Radcliff. Henry S. King & Co., 1879.

Amongst the cooler climates of this group, those of *Great Britain* and *Ireland* deserve our principal attention. There are great differences in the different regions, according to position, on the west or south-west coasts, or on the east or south-east coasts, and according to local configuration, aspect, elevation, and other special influences; but some points are more or less common to all, and produce a general character, of which we shall give a short sketch to avoid frequent repetition, when describing different localities.

The most prominent point is that the mean temperature is much higher than is due to the degrees of latitude, and that this excess of temperature occurs principally during the winter. This is strikingly illustrated in Alexander Buchan's* "Meteorology":—"If no more heat were received than is due to the position on the globe in respect to latitude, the mean winter temperature of Shetland would be only 3°, and that of London 17°. But chiefly owing to the heat given out by the Gulf Stream during winter, and carried to these places by the winds, their winter temperatures are respectively 39° and 38°—Shetland being benefited 36° and London 21° from their proximity to the warm waters of the Atlantic. In Iceland and on the Norwegian coast, the increase thus accruing to the winter temperature is even greater. To all these places the Atlantic may be conceived as a vast repository of heat, in which the warmth of the summer months, and that of more southern regions, is treasured up and reserved against the rigours of winter."

Whether this is due to the Gulf Stream alone, or whether the general equatorial current has a great share in it, as Carpenter suggests, we need not discuss here; what is uncontested is the fact that the climate of these islands is greatly benefited by winds carrying to them heat and moisture taken up from warm currents of the Atlantic, and by the actual contact with the warmer sea. The latter becomes evident if we compare the localities on the west and south-west coast with those on the east coast. The isothermal lines given by Buchan for January run, as regards Great Britain, not horizontally from west to east, but turn down from their normal direction at almost right angles, viz., from north to south. The summer isotherms, on the other hand, run much more parallel to the lines of latitude, and even rise somewhat towards the east, showing a slightly greater warmth in the east than in the west. Mild winters and cool summers, comparative absence of extremes, and a rather humid air, with many rainy days, are prominent features of this insular climate; they are, however, not wholly due to the fact that Great Britain is an island, but in a greater degree to the circumstance that the prevailing winds, during about eight or nine months, come from the south-west, that they are, therefore, saturated with water vapour, part of which, by the lowering of temperature on the cooler land, is condensed into water vesicles, mist, cloud, and rain. This air, rich in vapour and water vesicles, is less transcalent and less translucent than the air in dry countries; hence the sunheat is very much lower at Greenwich than in the high Alps (Waters and Frankland), and at the Riviera (Marcet), and the direct sunlight less powerful. On the other hand, the water vapour checks the radiation of heat at night, and thus equalises the temperature of night and day. With less sunheat during the day, and diminished cooling at sunset, the chill at sunset is in this country less great and less dangerous to delicate invalids than in the health-resorts of the drier and brighter Riviera.

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* "Introductory Text Book of Meteorology." Wm. Blackwood & Sons, Edin., 1871 (p. 70).

While we find in sub-tropical climates rainy seasons and dry seasons, the rainfall is distributed in Great Britain and Ireland over the whole year, although autumn and winter have a somewhat larger number of rainy days than spring and summer. Another point is that the total amount of annual rainfall is on these coasts distributed over a much larger number of days, even if the amount of rain deposited is the same. Thus, according to Dr. Hassall*, who has carefully examined the meteorological records of the Observatory at San Remo, the average annual amount of rain is 28·78 inches; this is nearly the same at Bournemouth, viz., 28·81 inches; but while the number of rainy days at San Remo is 48, that at Bournemouth is 156·3. The following table, based on a larger one given by Hassall, allows a comparison between these localities in the south and south-west of England with those on the Western Riviera.

	Days of rain.	Inches.
San Remo	48	28·78
Cannes	70	35·43
Hyères	63	27
Bournemouth	156·3	28·81
Ventnor	174·6	34·54
Torquay	200	39·60

But not only have these islands a larger number of rainy *days*, but on each rainy day the number of rainy *hours* is much greater than at drier and warmer health-resorts. At San Remo rain falls on "no more than 195·6 hours for the whole year, or a little more than eight days and nights." We are not aware of published records of the hours of rain on the coasts of Great Britain, but the figures would be much larger. At the Riviera and at most sub-tropical regions the rain descends heavily during a few hours, other hours of the same day being often entirely rainless and even bright; while in this country small quantities often fall during the entire day, the air and sky remaining constantly gloomy. The distribution of rain over so many hours gives time to the land to absorb the moisture, and later to evaporate it again throughout the whole year. Hence the beautiful green of the fields in these regions, compared with the scanty verdure and the parched state of the land during a great part of the year on the Riviera and similar regions.

The relative moisture is rather high in all parts of this country, varies in different localities, and is larger in autumn and winter than in spring and summer.

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* "San Remo and the Western Riviera." By Arthur Hill Hassall, M.D. Longmans, 1879 (p. 61).

In comparing the climatic qualities of these islands with those of other regions, we must always bear in mind that the *hygienic conditions*, though not yet perfect everywhere and at all times, are infinitely superior, as a rule, to those of foreign health-resorts, and that if they become through accidental circumstances very defective, the publicity of the fact generally soon leads again to their amelioration. Hence the health of the inhabitants is better, epidemic diseases, especially, are less frequent, the mortality is comparatively low, food and accommodation are good, and medical advice is everywhere in reach.

To sum up in a few words, the characters of the seaside places of Great Britain and Ireland are:—Rather high degree of humidity; greater warmth than is due to the geographical latitude; great equability with regard to seasons and periods of day; dulness of atmosphere; favourable conditions as to hygiene, diet, and accommodation; health-giving and tonic, though not agreeable climates, requiring a certain amount of energy of constitution.

Considering the size and shape of Great Britain and Ireland, and the direction of their coast lines, it is evident that there must be considerable differences in their climates. In a rough way, we may describe the west coast of Scotland and England as warm and moist, the east coast as rather dry and cold, while the western part of the south coast, as far east as Sidmouth, is moist and specially warm, the eastern portion—the south-east coast beginning from St. Leonards and Hastings—approaching in its characters the east coast, being drier and less warm than the south-west, but somewhat warmer than the east coast; the region intermediate between south-west and south-east, including Bournemouth, the Isle of Wight, Worthing, and Brighton, being fairly dry and warm. It is especially in winter, as already mentioned above, that the difference in temperature shows itself in a marked manner. A sketch of the isothermal lines for January given in A. Buchan's "Meteorology" (p. 71) manifests this in a most graphic manner. We must refer the reader to this sketch, and can only roughly state that we have on the west and south-west coasts of England and Ireland an increase of warmth of 3° to 6° over the east coast, and we see that the temperature gradually rises from the south-east towards the south-west coast. This difference is due to the winds from, and actual contact with, the sea, the warmth of which likewise decreases from west towards east, being in the neighbourhood of the Scilly Islands several degrees warmer than near Dover. The difference between the east and west gradually diminishes from January to May, with the increasing power of the sun's rays, and disappears in the summer months, when it is even sometimes reversed by easterly winds carrying part of the warmth of the adjacent continents to the east of Great Britain.

We cannot give here a sketch of the localities on these coasts which are used as health-resorts, but must restrict ourselves to a few of the most important ones. If we divide them into (*a*) *winter* and (*b*) *summer resorts*, we do not mean to indicate that the winter resorts are useful in winter only, and the summer resorts in summer only, for the former offer occasionally for some conditions advantages also in summer, and the latter may be often resorted to in winter by those who require less shelter.

WINTER RESORTS ON THE BRITISH COASTS.

Queenstown lies on the southern acclivity of the southern hill of the Island of Cove in Cork Harbour; it rises up in terraces almost from the water's edge, is well sheltered from the north, and quite open to the south. It has a remarkably mild, equable, slightly humid, and, to some constitutions, somewhat relaxing, climate. Its annual temperature is, according to Dr. Scott,* 51°·93; fall of rain, 33·95 in.; mean dew-point, 46°; mean winter temperature, 44°·21; mean spring temperature, 50°·17; mean of winter and spring, 47°·19. The mean temperatures of the year and of the seasons are very similar to those of Torquay, and higher than those of Hastings, Bournemouth, and Ventnor. Similar to those of Queenstown are the climatic conditions of *Glengarriff*, a harbour rich in beauty and with singularly indented coast lines, running in from *Bantry Bay*.

The best known winter resort in the *West of Scotland* is the *Island of Bute*, in which *Rothesay*, the capital, offers good accommodation. The little island is only eighteen miles in length from east to west, and four to six miles in breadth. It lies at the mouth of the Firth of Clyde, and is almost surrounded by the high hills of the opposite coast, the highest point of the island itself being only 140 above sea-level. Sir James Clark,† who, from communications by Mr. Thom, gives an accurate account, with meteorological tables, states "that the temperature never falls low during winter, nor rises high in summer, so that its yearly range is comparatively limited, being under 40°, which is at least 15° less than that of Glasgow. It rarely falls below 30°, or rises above 70°. In severe frosts on the mainland of Scotland, the difference between Glasgow and Rothesay is often from 10° to 15°."

Several other localities on the western coast of Scotland, and the adjacent isles, probably offer similar climates—viz., mild and equable, and rather humid; but the meteorological observations are as yet scarcely sufficiently advanced to allow an accurate appreciation.

The *Scilly Islands*, situated about twenty-five miles from Land's End and forty-two from Penzance, possess, according to Dr. Tripe's ‡ description, "the most equable winter temperature in the British Islands, if not in all Europe." The mean temperature of the five coldest months, November to March, was at St. Mary's, Scilly, 47°·9 in the four years 1873 to 1877; the mean maximum, 50°·5; mean minimum, 44°·5; mean daily range, 6°·0; mean monthly range, 18°·7; mean relative humidity, 89°; number of rainy days, 107; rain in inches, 17·13; winds from north and east, 56 days; from south and west, 90 days.

Penzance, in the extreme south-west of Cornwall, on the shore of the beautiful Mount's Bay, has little shelter from winds, but a remarkably equable temperature. The mean annual temperature according to Forbes is 51°·8, which is only 1°·4 more than London, but Penzance is 5° warmer in winter, 1° warmer in spring, 2° cooler in summer, and 2° warmer in autumn. The difference between the warmest and coldest months in London is 26°, at Penzance only 18°. The mean daily range at Penzance is only 6°, that at Camden Town, London (Symons), 11°; the mean monthly range at Penzance, 21°·3; at Camden Town, 32°·9.

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* "On the Medical Topography of the Cove of Cork." "Dublin Journal of Medical Science," vol. xiii.

† "The Sanitary Influence of Climate." By Sir James Clark, Bart. London, 1846 (p. 175).

‡ "The Winter Climate of some English Sea-side Health-Resorts." By John W. Tripe, M.D. "Quarterly Journal of Meteorology and Sciences," April, 1878.

Falmouth, to which place Dr. Tripe* in his valuable papers directs attention, about thirty miles to the east of Penzance, in the midst of a beautiful country, near a fine harbour, has a climate similar to Penzance.

Torquay lies on a beautiful bay encircled by hills covered with villas. The three principal hills are called the Braddons on the north; Waldon Hill, with a fine fir wood, on the west; and Park Hill on the east. Torquay is well sheltered from N. and N.W., and tolerably well from N.E., and this protection extends over a considerable part of the immediate neighbourhood, so that there is unusual opportunity for exercise as well on level ground as on gradual ascents—a great advantage to invalids. The general character of the climate is very much like that of Queenstown; but the air of Torquay is drier, and, according to Mr. Vivian, it is drier than at any other place in South Devon, which Sir James Clark ascribes in part to the limestone rocks that are confined to this neighbourhood, and partly to the position between two streams, the Dart and the Teign, by which the rain appears to be in some degree attracted. Different portions of the town differ greatly—that near the sea being more sedative and relaxing, that on the hills towards Babbacombe rather bracing, at all events by comparison; and the different aspects of the three hills offer to invalids a considerable choice.

Teignmouth has a picturesque situation, but is less equable, and not sufficiently sheltered to be generally recommended as a winter climate. It is in reality more suitable as a summer retreat to lovers of Devonshire scenery, as it is said to be more bracing during summer than the majority of other localities on this coast.

Dawlish, on the slopes of the two opposite hills of a beautiful little valley, is more sheltered from N. and N.W., but not from E. It, therefore, is not suitable in spring, while in winter it is warm, fairly sheltered, and the air and soil are tolerably dry.

Exmouth consists of an old and a new town; the former lies upon a hill, and is much exposed to winds from S.W., W., and N.W., but commands one of the finest views on the Devonshire coast. It is not suited for pulmonary complaints. The new town lies near the shore, is more sheltered, but is subject to occasional fogs from the river.

Budleigh Salterton, about four miles east, has more shelter, and is especially well protected from the north, but the space for sheltered walks is limited.

Sidmouth is well sheltered from N. and N.W., fairly from E., and partially from N.E.; it is open to the south. Dr. J. J. Mackenzie describes it as not less sheltered than Torquay. The climate is similar, but the annual temperature is, according to Mr. Vivian's tables, about two degrees less. In spite of great advantages, Sidmouth has made slow progress as a winter resort, while it is much liked in the later part of summer and autumn.

Salcombe is one of the warmest points of England, as shown by the myrtle, the lemon, the orange, and the aloe, which flourish there without much artificial help; it owes its warmth principally to the shelter afforded by high surrounding land; but the ground for exercise is too limited.

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* *loc. cit.*, p. 214.

There are many other localities on the south-west coast, which may be used as health-resorts for a shorter or longer time under special circumstances, which, however we do not mention, as the accommodation is not sufficient at present to render them available as winter resorts to a larger number of invalids.

Here we might mention also the *Channel Islands*, but owing to their exposure to winds from all quarters, they belong more to summer and autumn than to winter climates. Some localities on the north coast of Cornwall and Devon, as New Quay, Ilfracombe, Lynmouth, and Lynton, possess likewise many advantages as winter resorts, and are likely to be used as such in future years. We shall place them amongst the summer resorts simply because they are at present specially resorted to during summer and early autumn.

The centre of the *south coast* possesses two of the most important winter stations of England : *Bournemouth* and the *Undercliff.*

Bournemouth, on a bay of Hampshire, nearly opposite the western extremity of the Isle of Wight, lies partly in a basin, partly on the slopes of the surrounding hills, which are covered with fir trees. Many of the villas lie in the midst of small pine groves, by which the appearance of the entire place is rendered quite unlike other seaside places in England, and has been often compared with Arcachon. The agency of the pine plantations in the neighbourhood of both localities is certainly not confined to shelter from wind ; but their exhalations, and their whole organic life, exercise important influences on the surrounding atmosphere. The soil is dry, consisting of sand and sandstone. The hills afford good shelter from N. and N.E., and partly from E. winds, and this shelter is increased by the pine plantations; but to the milder winds, W., S.W., and S., the place is much exposed. There is, on the whole, more wind than at Torquay. The houses on the slopes of the eastern cliff are more sheltered from cold winds than those on the western. The meteorological observations of Drs. Mainwaring, Falls, and Compton show that the temperature conditions are rather similar to those of Torquay. If it is less sheltered, it is also less depressing. The amount of rainy days and atmospheric moisture may be called moderate.

Branksome, about two miles to the west, may be regarded as a continuation of Bournemouth ; partaking of the same characters of soil and fir plantations.

The *Isle of Wight*, small though it is, possesses a variety of climates. We shall defer the consideration of the summer climates to another place, and restrict ourselves here to the *Undercliff*, which has obtained a more than European fame by the description of Sir James Clark—a fame which has been upheld by the successful working of the model National Hospital for Consumption at Ventnor. The singular landslip on the south-eastern portion of the island, called the Undercliff, is a kind of terrace, about six miles in length, from near Bonchurch to Black Gang Chine. It is effectually protected from the N., N.E., N.W., and W., and to a great degree from S.W. It offers abundant space for outdoor exercise on almost rocky ground. The chalk and sandstone rocks rapidly absorb fluid, and leave the ground generally dry. The sun-warmth is increased by reflection from the cliffs, and in some situations by that from the sea. The elevation above the latter—about 50 to 60 feet—is sufficient to prevent any irritating influence. The climate, though mild and equable, is fairly dry, not relaxing; and the beauty of the scenery, together with the geological and botanical features, add greatly to the value of the Undercliff as a health-resort. The portion from *Bonchurch* to *St. Lawrence* is the most sheltered, and *Ventnor*, which is built on a series of small terraces, offers very good accommodation of varied climatic characters; for the different parts of Ventnor exhibit marked differences: some are close to the sea, some are from 30 to 60 feet above it, some have the sun longer than others, some are nearer to the rocks, others further away from them, being freely exposed to the air from all sides; some, again, receive more of the rays reflected from the rocks: others enjoy, in addition, the reflex from the sea, but, as Dr. Frankland has pointed out, only those houses from which the reflection of the sun in the sea can be seen.* The climate is suitable in tendency to consumption and the first stages of the disease, in chronic catarrh of the throat, larynx, and trachea, in scrofula, anæmia, especially chlorosis, general debility, retarded convalescence from acute diseases, &c.

On the *south-east coast* of England the most important places as winter resorts are *St. Leonards* and *Hastings;* both contiguous to one another, being sheltered by high cliffs from N., N.E., and N.W., but partly exposed to E., and entirely to S. and S.W. The climates of both are not exactly the same, Hastings being more sheltered and slightly more sedative, approaching in character the Undercliff; St. Leonard's more blowy, more resembling the localities further east on the coast. The lower parts of the town, being much nearer the sea and less exposed to wind, are somewhat warmer than the higher. The mean temperature of the five winter months (November to March), as given in Dr. Tripe's papers, is 41°·4, which is only 0°·4 warmer than at Camden Town, therefore 6° lower than at St. Mary's, Scilly, and 5° lower than at Torquay; but the mean daily range was only 8° at Hastings, while it was 8°·8 at Torquay, and 10°·7 at Camden Town; mean monthly range at Hastings, 27°·8; at Camden Town, 32°·7. The days of rain about the same as in London, 90 in five months; but the quantity at Hastings is greater than in London, 15·88 inches against 12·39; it is less, however, than at the other seaside winter resorts mentioned. The soil is dry, a thick layer of sand overlying wealden clay.

The winter climate of *Hastings* and *St. Leonards* is less suitable for those requiring shelter, warmth, and a humid and equable atmosphere, but cases of atonic gout and rheumatism, and atonic catarrh of the mucous membranes, and tendency to colds from weakness and atony of the skin are generally benefited here during the months of October to February; March being unsuitable on account of the east winds.

Llandudno, in North Wales, is sheltered by the Great Orme's Head from W., N.W., and N., and by a lower range from S. and S.E. All the winds to which it is specially exposed have passed over the sea, but they are sometimes, nevertheless, rather cold and frequently violent. Llandudno is best known as a summer resort, and as such it deserves a high place, on account of its two fine bays, its facilities for bathing in almost any weather, and the freshness of its air; but it claims also a good reputation as a winter resort, especially for those who can bear a certain amount of wind. Llandudno stands about intermediate between the winter resorts of the south-west coast and St. Leonards. The following are the principal meteorological features given in Dr. Tripe's papers, from observations by Dr. James Nicol in 1873 to 1877, between November and March:—

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* "Climate of Town and Country." By Professor Frankland. "Nineteenth Century," July, 1882 (p. 39).

Mean temperature	43°·5	Mean humidity	82°
Mean maximum	48°·3	North and east winds	44 days.
Mean minimum	38°·8	South and west winds	107 days.
Mean daily range	9°·5	Rainy days	83
Mean monthly range	28°·3	Amount	15·96 inches.

SUMMER RESORTS.

The coasts of the British Isles are well provided with localities which may be called good summer resorts, as well for invalids as for those requiring change from work or town life. There is, indeed, no country with similar advantages, and there are few sea-side resorts on the continent which can be compared with many of those on the English coasts with regard to their bracing influences. The majority of these places offer not only sea air, but also more or less perfect accommodation for sea-bathing. The best time is from July to October, but the climate of many of them is very good until December and January; and the localities on the south and west coasts, which are less affected by the east winds, may be resorted to during the whole of the year by persons not requiring special shelter.

We have not the space to give a description of the different places, but will only mention the more important ones in groups according to their position. The majority of those situated on the east coast have a decidedly stimulating character, are comparatively dry, exposed to the E. and N.E., have low annual and winter temperatures, and are moderately cool in summer; they can be specially recommended in summer and the beginning of autumn. On the coast of Scotland *Nairn* and *North Berwick* possess a deservedly high reputation, while *St. Andrews* and *Portobello* are likewise much resorted to.

On the coast of Yorkshire: *Redcar, Saltburn, Whitby, Scarborough, Filey,* and *Bridlington*; in Norfolk, *Cromer, Yarmouth, Lowestoft*; in Suffolk, *Aldborough* and *Felixstow*; in Essex, *Walton* and *Southend*; on the eastern side of Kent, *Herne Bay, Westgate, Margate, Broadstairs, Ramsgate, St. Lawrence,* and *Deal*; and on the south-east coast, *Dover, Folkestone, Sandgate, Hythe,* which have a slightly higher temperature, are to some degree sheltered from north winds by high downs, and continue to offer considerable climatic advantages till December and January—a remark which applies still more to the different stations on the Sussex coast: the *cliffs* above Hastings and St. Leonards, *Eastbourne, Seafort, Brighton* and *Worthing, Littlehampton* and *Bognor*—all these localities, as already stated, are of a more or less *tonic* and *bracing* character, but there are wide differences between the different places, and even between different portions of the same place. At *Folkestone*, for instance, the houses situated close to the beach are almost entirely sheltered from the north, so that the air feels on hot and sultry days very close, and is, on the whole, less bracing, while those on the west cliff receive the air from all sides, so that one always has a sensation of freshness. Furthermore, the houses near the beach are much more under the influence of the sea, and in consequence some persons become more easily bilious when staying there than on the cliff, which is fully 50 feet above the sea. At *Brighton*, to give another instance, there is quite as marked a difference between houses situated at the King's road and Brunswick Terrace and those high up near Montpellier Square. Between the western and the eastern side the difference is likewise considerable, the latter being colder, more exposed, and more bracing, the former lower and more sheltered. Still more remarkable is the difference between the Marine Parade on the cliff and the newly-arranged grounds just underneath the cliff, which enjoy the most perfect shelter from N. and N.W., and on a sunny winter's day remind one rather of the Rivieras than of Madeira, so that the name " Madeira Walk " is a decided misnomer.

The places situated to the west of Brighton are somewhat less stimulating, but again differ greatly amongst themselves according to position and aspect. Prominently in this group is the *Isle of Wight.* We have already mentioned the Undercliff on the south-east coast amongst the winter resorts. Good, mild, and fairly-dry summer and autumn climates are offered by *Shanklin* and *Sandown* on the east; *Sea View* and *Ryde* on the north-east; *Cowes* and its neighbourhood on the north. *Yarmouth* and *Alum Bay*, on the north-west, are, to a certain extent, under the influence of the Atlantic, which is in still fuller force on the western coast, of which *Freshwater* may be regarded as the representative.

The principal localities on the south coasts of Hampshire, Devonshire, and Cornwall we have mentioned under the winter resorts; but these, as well as *Southsea*, *Swanage*, *Weymouth*, *Lyme Regis*, *Seaton*, and *Exmouth*, which on account of insufficient shelter have not been mentioned there, may also be resorted to in summer by those who do not bear bracing climates, and feel better in mild and somewhat relaxing air, for it cannot be denied that there is a relaxing element in these localities in summer. There is, however, an erroneous idea abroad that the south-west coast is very hot in summer, while Torquay, for instance, and Sidmouth and Penzance are actually cooler than London and Exeter and Clifton, as the following table shows :—

	Summer.		Summer.
London	62°·3	Torquay	61°·26
Clifton	63°·87	Sidmouth	60°·25
Exeter	62°·08	Penzance	60°·20

The *Channel Islands*, which in their climates resemble the south-west coast of England and the coast of Brittany, are more thoroughly marine than either. The comparatively high temperature and absence of extremes is manifested by the vegetation. Camellias, myrtles, hydrangeas, thrive freely; figs, melons, and grapes ripen without artificial heat; and pears are unrivalled.

The north coasts of Cornwall and Devonshire are moister and more equable than the east and south-east coasts of England, but they are fresher than the south coasts of their counties, and the beauty of the scenery and scope for excursions justly attract many visitors, who either cannot bear, or are not in want of, decidedly bracing climate. *New Quay* and *Bude* in Cornwall promise to become very useful resorts; *Barnstaple, Ilfracombe, Lynton,* and *Lynmouth* are the most attractive places on the North Devon coast; and the meteorological tables published by Dr. Tripe for Barnstaple indicate that the winter climate is well adapted for many delicate constitutions if they are able to bear a certain amount of wind; the more so as Ilfracombe is during the five months from November to March 1°·3 warmer than Barnstaple, and only 0°·5 colder than Torquay, while the rainfall is less than at Torquay in each month. *Minehead, Weston-Super-Mare, Clevedon* on *Portishead,* on the Bristol Channel, have the disadvantage of large muddy sand-fields in low water, but they are quiet, unpretending places, with beautiful walks, and their climate, though less fresh than the north coast of Cornwall, can scarcely be called relaxing.

On the south coast of Wales the most important place, with a mild, fairly dry, but decided sea climate, is *Tenby;* further east, with less decided sea climates but in beautiful situations, are *Llanstephen* and *Ferryside.* The west coast of Wales has only two places where climatic advantages are combined with good accommodation, viz., *Aberystwith* and *Barmouth,* both having rather mild and humid climates with fair shelter from E. and N., and entire exposure to W., S.W., and N.W. Barmouth has, however, the drawback of large muddy sand-fields during low water. Unpretending, and somewhat similar to Aberystwith, is *Aberayron,* at the point where the river Ayron flows into the Bay of Cardigan.

The localities on the north coast of Wales, though somewhat fresher, belong likewise to the mild and rather humid climates: *Beaumaris* on Anglesea, at the entrance of the Menai Straits, in a splendid position and with good sea-bathing; *Aber, Penmaenmawr, Llandudno* (already mentioned amongst the winter resorts), *Abergele,* and *Rhyl.*

The coasts of Cheshire and Lancashire, under the influence of the Irish Sea fully exposed to the west winds, share with the whole of the west coast rather high annual temperatures, cool summers, tolerably mild winters, and somewhat humid air.

Southport is the principal locality, and offers good accommodation, but *Hoylake, New Brighton, Lytham, Blackpool,* and *Fleetwood* are likewise valuable resorts in those busy regions. *Grange,* in Morcambe Bay, has a beautiful and very sheltered situation, and may serve as a winter station, but only for short periods of time, as it lacks enlivening qualities for prolonged residence.

The *Isle of Man,* with good accommodation at *Douglas* and *Ramsey,* has an entirely marine climate, being situated in the midst of the Irish sea, about 82 miles from Liverpool. The mean temperature of the year is about that of London, 49°·5, but that of summer is only about 58°·6, therefore nearly four degrees less, and that of the hottest month, July, 60°·2. The summer climate is more bracing than that of any locality near the western coast, and the sea-bathing is very good. This island deserves to be more appreciated.

Silloth, on the Solway Firth of Cumberland, has a mild and comparatively dry climate. The number of rainy days, viz., 150, and the amount of rain, viz., 32·6 inches, are not very great, and would probably be greater if the mountains of

Scotland and Cumberland did not draw off part of the moisture. The soil is sandy, and the sea-bathing is good.

Ardrossan, in Ayrshire, is one of the youngest marine health-resorts, sharing the climatic qualities of the west coast—viz., cool and rather humid summers with temperate autumns and winters. Near the *Firth of Clyde* are some unpretending and agreeable localities with a marine climate, somewhat modified by river and hills; the best known of them are *Dunoon*, *Tunellan*, *Largs*, *Millport*, *Wemyss Bay*, *Skelmorlie*, and *Gourock*. All these localities, together with *Rothesay* on *Bute*, which we have mentioned among the winter resorts, are useful summer and autumn stations for the industrial centres of the west of Scotland, as Glasgow or Greenock; but they can scarcely be called bracing when compared with the localities on the east or south-east coasts of Scotland and England; and the mortality at the Clyde health-resorts is decidedly higher than that of the average English seaside ones.

The coasts of *Ireland*, too, are well provided with excellent summer resorts, and good bathing places. *Bray*, *Howth*, and *Kingstown* possess the mild and humid climate of the east coast of Ireland; and also *Dundrum* and *Holywood*. *Rosstrevor* and *Warrenpoint*, in Down, are a few miles removed from the sea, but are nevertheless under its influence; they combine, therefore, to some degree, a modified sea air with beautiful inland scenery. *Port Rush* and *Port Stewart*, on the northern coast, on sandy soil, in a basaltic district, have a rather less humid climate, and are regarded as more bracing. *Bundoran*, in the Donegal Bay, is exposed to the influence of the Atlantic, which is still more the case with the coasts of Mayo and Clare. *Kilree*, in the latter county, and *Kilrush*, on the estuary of the Shannon, are much visited, on account of their healthy climate and natural beauties. Some localities on the south and south-east coasts have the mild, equable, and humid character, of which *Queenstown* and *Passage* in the harbour of Cork, are representatives, and also *Glengarriff*, near Bantry Bay, already named amongst the winter resorts.

Very different from the climates of the Irish coast is the island of *Heligoland*, in the German Ocean and near the German coast, with a thoroughly bracing marine climate, fair accommodation, and good sea-bathing.

Somewhat allied to the climate of the south-west coast of England is that of the *north-west coast of France*, and especially the Department of Finisterre. This similarity is caused by the influence of the Atlantic and its warm currents. The *north coast* of France is drier, less equable with regard to temperature, and may be called stimulating. It is rich in health resorts, with good bathing, good accommodation, and agreeable social relations. The season is from July to September, and few visitors are to be seen before or after the season. The principal places from west to east are:—*Dinard*, in a healthy and beautiful situation, opposite St. Malo, with which it is connected by a steam ferry, and about ten miles from *Dinan*, one of the most attractive and interesting old towns in Brittany; both localities being favourite places for longer residence with English as well as American families. *Cabourg*, at the mouth of the Dives, and *Beuzeval* are both unpretending, and, close by, *Houlgate* and *Villers-sur-Mer*, which latter is much liked by those who prefer a more quiet and somewhat less expensive place than either *Trouville* or *Deauville*, the most fashionable seaside resorts on this coast; both are in close proximity to one another, and are provided with excellent hotels and private lodgings, fine walks, and every kind of amusement. The sands and bathing are very good. *Etretat*, formerly only a small fishing village, has very picturesque cliffs of fantastic forms, and fine walks; and is the favourite residence of some French artists. *Fécamp*, a few miles further on, on the shore, is a larger town, to the west of which an *Etablissement de Bains de Mer*, an hotel, and villas are constructed for the accommodation of visitors. *Dieppe*, though one of the chief fishing ports of France, is likewise a favourite and fashionable marine resort, not quite so simple as Etretat, but with many interesting localities in the neighbourhood. *St. Valery en Caux*, another small fishing town, has fair accommodation for sea-bathing, and is said to be the place where William the Conqueror embarked for England. *Tréport*, the port of *Eu*, has likewise risen into a favourite sea-bathing resort, with a large establishment, and a fine promenade along the sea. *Boulogne* and *Calais* are too well known to require description. The smaller places are to most people preferable as health-resorts.

The *Belgian coast* possesses in *Ostende* one of the most renowned seaside resorts in Europe. The sands are unrivalled, the waves are very powerful, the shore is exposed to every breeze; the animation and occasional naïveté of the social life are very attractive; but the natural beauties of country such as are offered by many English places are absent. *Blankenberghe* was until lately a much more simple place, but is now another Ostende.

Heyst, a fishing village about four miles further along the coast, offers equally good sea-bathing, fair accommodation, and is not subject to the social taxes of expensive dresses.

Scheveningen, on the *Dutch coast*, about three miles from the Hague, is one of the most agreeable and best arranged seaside resorts on the Continent. The immediate neighbourhood of a beautiful forest, intersected with numerous walks, and of the Hague are great attractions.

The *German coast* contains likewise some well-situated, bracing sea places, mostly on small islands, which are likely to be in time much more developed than they are at present. They have all highly stimulating and tonic climates, good sea-bathing, with powerful waves. We will only name the principal localities without any comments, as they are not yet likely to be wanted by either English or Americans:—*Borkum*, *Norderney*, *Baltrum*, *Langeroog*, *Spikeroog*, *Wangeroog*, *Dangast*, *Cuxhaven*, *Wyk on Föhr*, and *Westerland on Sylt*.

The localities on the shores of the *Baltic* are less stimulating, but most of them have the advantage of beautiful forests. They are excellent summer resorts for the inhabitants of the north of Germany. *Marienlyst*, *Dusternbrook*, *Travemünde*, *Doberan*, *Warnemünde*, *Putbus*, *Heringsdorf*, *Misdroy*, *Swinemünde*, *Rügenwalde*, *Colberg*, *Zoppot*, and *Cranz*.

The coasts of Norway, Sweden, and Denmark possess likewise seaside places with thoroughly stimulating climates.

The *southern hemisphere* contains, no doubt, many localities which might be placed in this climatic group; but they are as yet of limited value as health-resorts. Important, however, is *Tasmania*, to the south of Australia, from which it is separated by Bass's Strait, between 40° 4′ and 43° 35′ S. Lat., and 144° 4′ and 148° 25′ E. Long. The island possesses lofty mountains and large forests, and must, therefore, contain different climates. The proximity to Australia exposes it occasionally to hot N.W. winds from the Australian continent, but these generally do not last long, and are mostly succeeded by polar winds from the south, leading to rain and rapid fall of temperature. The seasons are the reverse of ours, and during the winter—June to August—frost and snow are frequent in the interior. Spring—from September to November—is usually bracing, a bright sky alternating with passing showers and high winds; summer—from December to February—moderately warm; autumn—from March to May—being the most agreeable part of the year. Dr. Brown, in his work, "Australia for the Consumptive Invalids," 1865, describes Tasmania as enjoyable, and from its insular position and degree of latitude, more humid, cooler, and more equable than Australia. *Hobart Town* is for the present the most healthy town, in a beautiful situation close to Mount Wellington, which is over 4,000 feet high. Mean annual temperature, 52°; winter, 43°; summer, 62°·7. The number of rainy days seems to vary considerably from 100 to 130 and more, and the rainfall from 14 to 25 inches. In *Launceston* more rain seems to fall, and the climate is less equable. The mortality is given as from 20 to 23 per 1,000 inhabitants.

An intelligent traveller* who lately stayed for some time at Hobart Town, says: "The climate is similar to that of England, only very much finer and brighter, and nearly all English flowers and fruits grow there in the greatest abundance, and of most excellent quality." "English fruit trees attain a size and quality which they hardly ever acquire in their native soil. The peaches, pears, apples, currants, and gooseberries are all excellent, and the mulberries such as I never saw them before, or ever expect to see them again."

Tasmania is a health-resort for the Australian colonies, and can be used for shorter or longer stays on sea voyages.

III. DRY MARINE CLIMATES.

We shall consider here only the warmer localities, for the cold and dry marine localities are not yet used as health-resorts.

The group which interests us most in this class is the *Riviera di Ponente* or *Western Riviera.* We have discussed some of the principal peculiarities of the Mediterranean group when treating of the warm marine resorts with *mean* humidity. The climate of the district extending from Hyères to Alassio possesses, however, some special characters, which we shall mention only very briefly, as we have the advantage of being able to refer to some carefully and attractively written works and papers on this region in the English language by Drs. J. H. Bennet,† C. T.

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* "Winters Abroad." By R. H. Otter, M.A., 1882.

† "Winter and Spring on the Shores of the Mediterranean," 5th Ed., 1875.

Williams,[*] Marcet,[†] Sparks,[‡] H. Hassall,[§] and others. The narrow strip of coast called the Western Riviera has a dry soil, generally limestone, is open towards the warm and warmth-spending Mediterranean, is more or less sheltered by a barrier of mountains, which not only prevents access to cold winds, but increases the temperature of the air partly by reflection, partly by absorption of heat during the hot parts of the day and year, and by giving it out during the cold parts. Thus the temperature during the six cold months of the year is 8° to 10° Fahr. higher than in London, viz., about 52°·5 against 43°. The relative moisture of the air is moderate, viz., about 65° to 72° against 88° to 90° in London; the number of rainy days is small, about 45 to 50 during the six months, half of what it is in England; October, November, December, and March being wet, January and February dry. The number of sunny days is about five times greater than here, viz., 110 to 120 during the season; fog and mist are as much as absent; the thermometer seldom sinks below 29° or 30° at night, and this rarely. The sunheat is very great; the mean difference between the black bulb thermometer in the sun, and the shade temperature being about 73° Fahr. during the winter months, viz., 128°·9 Fahr. in the sun, and 55°·9 in the shade.[‖] There are in addition to the general winds the daily land and sea breezes, by which the air is kept sufficiently purified. The most marked general winds are the north-west or "mistral," the south-east or "sirocco," the north-east or "greco." The fiercest wind is the *mistral*, which blows principally in March, but there are occasional violent north-west winds at other times in winter and spring. It is, according to Marcet and others, always attended with a low state of barometer. The *south-east* wind (sirocco) blows only now and then for some days, and is then almost always followed by heavy rain, although it seems not to be in itself a moist wind. The *north-east* wind (greco) is less frequent at the Western than at the Eastern Riviera; but is usually a biting cold wind when it blows, "often accompanied with sleet, hail, or snow." The east wind proper is not a frequent wind during the season at the Riviera; and the north wind, or tramontana, is almost entirely kept off by high mountain chains.

It may be generally stated that during the six months of season the air is tolerably calm on 60, moderately agitated on 80, and more or less violently so on 40 days; that December and January are the least windy months. There is everywhere sufficient opportunity for exercise in most attractive localities. The effect of the climate is stimulating and exhilarating.

The *disadvantages* are the great difference between sun and shade temperatures, and south and north sides of houses; sudden change in temperature, with some condensation of moisture at about sunset; the frequency of wind and of clouds of dust in the atmosphere. To this must be added that the social life offers too many temptations to the invalid, who, according to an injurious habit prevailing in this district, does not generally place himself under the entire control of his doctor, but is often guided by his own inclinations and the irresponsible advice of friends whom he is eager to join in their doings. It ought further to be borne in mind always that the climate of the Riviera is not always to be depended on, and cannot be calculated beforehand. All that one can say is that it is most probable that the number of fine days will greatly exceed those in the British Isles, or in Germany, or Switzerland, or the central or northern parts of France, but entire weeks and months, nay, whole seasons, may be very bad; and the finest days may be followed by the worst.

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[*] "The Climate of the South of France," 1870, and "The Influence of Climate in the Treatment of Pulmonary Consumption," 1877.

[†] "On the Mediterranean Coast of the South of France in its Medical Aspects," and quite lately—"Southern and Swiss Health Resorts," 1883.

[‡] "The Riviera:—Sketch of the Health-Resorts." [§] "San Remo and the Western Riviera."

[§] Sparks, *loc. cit.*, p. 2—quoting from "Teysseire's Observations at Nice."

The best time for these localities is, in general, from the end of October to the end of April; some invalids ought to arrive later, some ought to leave earlier, some to stay longer, according to the nature of the individual condition. Some do well to stay the whole time at one place; others require a change from one locality of the same coast to another; others again must seek in February a different climatic region in order to escape the dry winds of the Riviera. Few only can return with impunity direct to their homes; the majority ought to spend part of April, May, and the beginning of June at intermediate stations; for instance, near the Italian and Swiss lakes.

The invalids to whom a stay at the Riviera may be recommended belong to those who require, as necessities of life, sun, warmth, light, moderate dryness of air, good food, and comfort, who in their own sunless, wet, cold, and changeable countries become mentally and physically depressed, unable or unwilling to take open air and exercise, lose appetite and strength, deteriorate in tissues, and thus run the risk of the development of disease or the progress of already existing morbid affections. Such individuals are to be found amongst those who are more or less permanently delicate by constitution or organisation; amongst those who are weakened for the time by physical or mental influences, as acute diseases, accidents, residence in unhealthy localities, overwork, worry, or other depressing causes; amongst the scrofulous; the naturally or prematurely old; the anæmic; the rheumatic; and the gouty; they are to be found also amongst those suffering from chronic catarrhs of the respiratory or intestinal mucous membrane; from phthisis; from the remains of pleurisy and pneumonia; and from other conditions which might lead to phthisis. The climate of the Riviera may also aid in the management of different affections or derangements of the digestive, urinary, and sexual systems. It ought, however, always to be borne in mind here, as everywhere else, and in every kind of treatment, that it is not the name of the disease which ought to be the guide in the selection of a climate, but the constitutional tendency and the condition of the invalid. In phthisis, for instance, those who are apt to become febrile with every slight cold, those who have a dry nervous cough, or who have constant laryngeal irritation, generally do better in moister and more equable climates; hysterical conditions and neuralgic affections are likewise not suited to the Western Riviera, at least not to the localities close to the sea, and are more likely to improve in inland climates, with moderate elevation above sea-level, and somewhat moister atmosphere.

Hyères, the most western health-resort of this group, lies not actually at the sea-shore, but about three miles away from it, and about sixty feet above sea-level, on a slope at the foot of a steep hill. It has a southern and south-eastern aspect, is well protected from N. and N.E., but almost entirely open to N.W., the region of the mistral, while the force of the south wind is diminished by the Isles des Hyères, a few miles distant from and parallel to the sea-shore. The climate of Hyères is very good between November and the beginning of February, with many calm and sunny days; it ought to be avoided after this period by those who are unable to bear the mistral, or at all events the greatest care ought to be exercised. With judgment much may be achieved. Dr. Griffith, the able physician of Hyères, is himself an instance, and circumstances are now better than at the time of his arrival; the tramway to the seashore, for instance, takes invalids amongst the pines, where they can walk and inhale the aromatic air without much fatigue and exposure. In April and May Hyères offers again more advantages. Many cases, complicated with nervous irritability, do much better here, because it is less under the direct influence of the sea than Nice and Mentone. More sheltered from the mistral, and in the midst of beautiful pine plantations, is the valley of *Costabelle*, about two miles from Hyères. There are beautiful walks sheltered by the trees, even while a mistral is blowing; and there is now, Dr. Griffith informs us, a good hotel at the disposal of visitors.

Cannes, on the magnificent Bay of Napoule, is one of the most beautiful spots in Europe. It is open to the south, where, however, the Iles des Lérins (Ste. Marguérite and St. Honorat), somewhat break the occasional fierceness of the wind; it is sheltered on the west by the picturesque Esterels, on the east by the Cape Croisette, on the north, north-west, and north-east, first by a chain of low partly-wooded hills, behind which rise higher hills, forming part of the Maritime Alps; but this shelter is by no means complete; the nearer hills, lovely though they are by their varied shape, and colour, and vegetation, are too low, and the higher chains are too far removed; the mistral especially is not entirely kept off, but enters partly by a kind of gap in the north-west region, partly by sweeping around the Esterel mountains. A ridge projecting from the northern range of hills, the Mount Chevalier, on which part of the picturesque old town stands, runs to the sea-shore, and divides the bay into two unequal parts—the western larger one, which is somewhat more exposed to the mistral but rather more sheltered from east, and the smaller eastern, in which the east wind blows with more force, the mistral with less. The western portion is more airy; the eastern runs up towards *Cannet*, and offers in the neighbourhood of that little town very sheltered situations. The vegetation, delightful though it is to those coming from the north, shows that the shelter is not so perfect as, for instance, in the eastern part of Mentone. In spite of this the long experience of careful physicians like Dr. Frank and Dr. Bright shows that with due care and judicious utilisation of the protected nooks and pine plantations, chronic, not too erethic, forms of phthisis can often be arrested and ultimately cured; while to many of the other conditions mentioned in the introductory paragraph to this group, the more airy situation of Cannes, the ample scope for exercise, the exhilarating character of the whole region, and the social surroundings are great advantages.

Cannes possesses also in its neighbourhood some localities which may be resorted to for a few days or weeks without any fatigue—a matter of greater importance to many invalids than is generally recognised. Our attention has been specially directed by Dr. Frank to *Grasse*, which lies on the slope of the mountains, eight or nine miles from Cannes, at an elevation of about 1,000 feet above sea-level; it has a southern aspect, a splendid view, and is tolerably well sheltered. The late Dr. Sparks spoke highly of the *Hotel Garibondy*, only three miles from Cannes, on the road to Auribeau; standing on an eminence formed by a mass of gneiss.

Nice, the next station on the Riviera, is so well known that it is not necessary to praise it. It has some very beautiful spots, is bright and sunny and stimulating, but is also very dusty and windy. *Carabacel*, in the new town, is tolerably sheltered from the north, and *Cimiez*, higher up in the same direction, still more so; but neither of them is perfectly sheltered. Cimiez, at all events, has the advantage to many of being some distance from the sea, the dust, and social temptations.

Villafranca and *Beaulieu*, between Nice and Mentone, are both well sheltered and in beautiful situations, so that they are likely to rival some day the fashionable places of the day. *Monte Carlo*, just above Monaco, is not only well protected, but has also a very delightful position.

Mentone has become a household word in the English language. The bay of Mentone has a south-easterly aspect, and is divided by a projecting rocky ridge, on which the old town is built, into an eastern and western part. The smaller *eastern* bay may be called the most sheltered spot in Europe amongst those localities which are to any large extent used as health-resorts. It owes this shelter principally to the peculiar bend of the small bay, to the steepness of the rocky mountain rising immediately behind it, and to projecting ridges on the east as well as west. The *western* bay is larger and much more open; the nearest higher protecting chain is about three or four miles distant, but lower hills run down from this to the shore, leaving between them gaps for small rivers, by which the air of the bay is "ventilated," the ventilation being sometimes felt like a cold blast; but on the whole there is not much reason to complain of this, as there are several sheltered regions for exercise. The beauty of the gently ascending and descending walks on the lower hills is very great; the views are always lovely, sometimes grand. There are hotels and villas close to the sea, and others judiciously placed at some distance on rising ground, with large sunny fronts. To those affected with phthisis, in the first and second stages, if they require and can bear heat, shelter from wind, occasional total absence of perceptible movement of air, and the immediate proximity of the sea, the eastern bay offers probably more than any other locality on either the Rivieras or any other marine residence in the whole of Europe; but some lose appetite and sleep, and are obliged to remove to the western bay, or to totally different climatic conditions.

Bordighera, the first health-resort on the Italian part of the Riviera, is famed for its palm groves. The old town is a picturesque object on a promontory; the new town, which is the health-resort, lies to the west of it in a small plain, to the back of which are thicker olive groves than almost anywhere else on the Rivieras, partly on level, partly on rising, ground. These groves contain promising sites for future villas, while the majority of the present houses and hotels are rather too near the dusty road. Bordighera is, on the whole, rather windy, though the winds on arrival, even the mistral—which is here felt as a west wind—have been more or less in contact with the warm sea, and have thus lost part of their biting character. An exception is formed by the winds which reach the neighbourhood by the valley of the

Nervia. These cold winds, though they do not flow direct on Bordighera, nevertheless exercise a marked influence on the air while they blow. Bordighera is, therefore, at present not suited to invalids requiring much shelter, but then it has advantages for the other classes mentioned in the general remarks.

San Remo consists of the quaint, old, pyramid-shaped, truly Italian town, and the numerous villas and hotels along the road and amongst the olive gardens to the east and to the west of it. It lies in a wide bay, open towards the south, at the foot of an amphitheatre of hills and mountains protecting it by a triple chain, tier upon tier, rising from the height of about 500 to that of nearly 4,000 feet. The nearer hills are wooded, and in shape less bold and picturesque than those near Mentone and Nice, giving to the whole region a tamer appearance. The soil is principally clay, and this may cause a somewhat greater humidity of the air, and, through this, greater equability of temperature. The amount of rain and the number of rainy days do not exceed those of the other Riviera resorts, and the temperature does not materially differ from that of Mentone. The east and south-east winds are mostly felt during the spring months, and the mistral is not altogether absent, though much less severe than at Hyères or Cannes. Altogether, the climate is one of the mildest on the Rivieras: less stimulating than either Cannes or Nice or Bordighera; so that many people sleep well at San Remo who complain of want of sleep at the three places mentioned, and some nervous persons bear this climate who cannot stay at Nice or Mentone.

The newest candidate for the health-resort certificate on the western Riviera is *Alassio*, about thirty miles east of San Remo, in a bay with south-eastern aspect, about five miles wide, tolerably well protected by a semi-circular range of hills, between 800 and 1,800 feet high. The shelter is somewhat less perfect than at San Remo, and the principal hotel is rather too near to the sea. The accommodation is not yet quite so good as at the older health-resorts, but those requiring no special shelter, and who are satisfied with fair, though not luxurious, accommodation, will find in Alassio a winter residence with much natural beauty, and in Dr. Schneer and Dr. Dickinson physicians well acquainted with the advantages and drawbacks of the climate. It is to be regretted, Dr. Sparks justly remarks, that gas is introduced into the rooms of the principal hotel.

Southern Italy has attractions which it is difficult to resist; the charms of nature are assisted by historical associations: *Magna Græcia*, with its Greek colonies, has exercised the widest influence on the culture of Rome and ancient Italy. The site of *Naples*, with the incomparable magnificence of its bay, and Vesuvius, with its curling smoke, will never cease to decoy health-seekers into its precincts; but fascinated as we may be by nature as well as by the treasures of ancient art which it contains, we dare not describe it as a *health-resort* at present, on account of the unhygienic conditions of which it has not yet been freed.

The Bay of Naples, however, ought not to be entirely shunned by those who are in search of sunshine and health, for *Castellamare* and *Sorrento* are both eligible residences in spring and autumn, and to heat-loving persons even in summer. Castellamare, or Castellamare di Stabia, is the old *Stabiæ* which Galen used to recommend to his consumptive patients as a mountain health-resort, and we can well imagine that many cures have been effected in the earlier stages of phthisis by the removal from the unhealthy conditions of Roman life to the pure air and abundance of good milk in these regions; but we cannot ascribe these effects to the slight elevation above sea-level. The rulers of Naples have repeatedly sought refuge here from the epidemics of their metropolis, and have given to their villa the beautiful name, "*Qui si Sana*," which is now that of the very good hotel above the town, with the most refreshing shady walks in its immediate neighbourhood. Castellamare has also fair arrangements for sea-bathing, and muriatic alkaline springs, of which Dr. John Macpherson has given an interesting account.

Sorrento, the ancient Surrentium, is the favourite summer resort of the Neapolitans during the bathing season, and is well adapted for this by its open position on rocks rising precipitously from the sea, surrounded with luxuriant lemon and orange gardens, and exposed to the north winds. There is scope for many beautiful excursions on and along the sea, and into the southern Apennines, with the Monte San Angelo. For the majority of the natives of northern and north-western Europe, however, Sorrento would be too warm in the height of summer, while in spring and autumn it would be a delightful residence. *Vico Equense, Meta,* and *Massa Lubrense* are suitable for similar purposes, but the accommodation is less good.

Equal in beauty to the position of *Sorrento* is that of *Amalfi,* on the north-western shore of the Bay of Salerno. It is very sunny in winter, has a large number of fine days, and is exhilarating, but it is only partly sheltered from the north, as a ravine on the side of Amalfi gives access to biting north winds. Similar are the positions of *Atrani, Maiori,* and *Minori.*

Salerno itself, the famous Salernium, with its medical school, has entirely lost its former climatic reputation, for the malarious air from the marshes near Pæstum, with its wonderful Greek temples, is carried at times to the region of Salerno.

The beautiful Island of *Capri,* so full of interest to the tourist, offers on its northern shores no sheltered habitations; the southern portion is to some degree protected from north and north-east winds by a chain of hills, and the village of Capri, about 450 feet above sea-level, has good accommodation at the "*Qui si Sana*" and several other inns. On the whole Capri is more suitable for spring, summer, and autumn than for winter.

The Island of *Ischia* is too much exposed in most parts for winter residence, while during spring, summer, and early autumn *Casamicciola,* on a cliff at the northern foot of the Epomeo, forms an agreeable residence, with hot springs, justly famed in the treatment of chronic rheumatism. The fear of earthquakes or similar sources of danger will, however, for many years to come prevent our recommending it.

The Island of *Malta* is too windy to be suggested as a health-resort in active diseases of the lungs, though occasionally in chronic cases some satisfactory results have been observed. The absence of shade is likewise a drawback, but in some forms of chronic rheumatism the sun-warmth, combined with moderate dryness of air, unless a moist sirocco blows, is useful. The best time is from the middle of October to the beginning of April.

The *Balearic Islands.*—*Majorca* and *Minorca* may be regarded as health-resorts of the future. Majorca, or Malorca, the largest island, possesses several sheltered localities, and with regard to *Palma*, on a bay which opens to the south, we possess some scattered but satisfactory experience on stationary cases of consumption and chronic bronchitis. The mean annual temperature is, according to Hann, 64°·6; winter, 52°; spring, 61°·3; autumn, 67°. Amount of rain about 19 inches. *Mahon*, a seaport on Minorca, has a slightly lower temperature and more rain.

The *Mediterranean coast of Spain* contains several fairly satisfactory localities belonging to this class of climates. *Barcelona*, on the north-east coast of this peninsula, is open to the sea towards south and south-west, and sheltered by a range of hills from northerly winds; it has good accommodation and fine walks on level and gently rising ground. *Alicante* is, like the whole coast of Murcia, drier and warmer than Barcelona, and is fairly screened from cold wind, but not entirely so. *Valencia*, only a little further north than Alicante, and on the same coast, has a much more humid climate, and belongs to the sub-class of warm and moderately humid climates. *Malaga* is described by Francis, who has specially studied the climate of Spain, as the mildest place in Europe; it lies on sand removed from the sea, has an eminently dry soil, a south-eastern aspect, and is surrounded by a semicircle of mountains rising to the height of 3,000 feet; it is protected on the N. and N.E., but exposed to the biting, dry N.W. The winter temperature is about 54° to 55°, and that of spring over 62°; both, therefore, considerably higher than any place on the Rivieras. The daily range is said to be less than 5°. The average number of rainy days is only 40, and the air is dry; the sky is remarkably bright; the light intense.

On the African coast, *Alexandria* and *Port Said* may be named as belonging to the dry marine climates, but not as health-resorts. The same may be said of *Smyrna* in Asia Minor, and *Larnaka* in Cyprus.

Athens, in Greece, has a dry and bright, but very changeable, climate; quite unfit for affections of the respiratory organs; but diplomatic, mercantile, and professional men affected with gouty, neuralgic, and rheumatic affections, have repeatedly found relief from their complaints when their duties required a prolonged stay at Athens.

South Africa possesses a variety of valuable climates as yet imperfectly known. We shall at present confine ourselves to a few localities on the coast, deferring the consideration of the interior mountainous districts until we come to treat of the mountain climates. The most important place is *Capetown*, on the shore of Table Bay, at the foot of Table Mount, which has a height of over 3,500 feet. The climate of Capetown is dry, moderately warm, and stimulating. The mean winter temperature is, according to Mann's "Colony of Natal," about 57°; that of spring and autumn about 64°; that of summer 71°. The amount of rain about 22 inches; the relative moisture between 70° and 80°. The hygienic conditions are fair; the drawbacks are wind and dust, especially in the streets of Capetown. The marine suburb *Sea Point* is preferable for invalids, and still more so *Rondebosch* and *Wynberg*, some miles away from Capetown. Wynberg is beautifully situated in the midst of pine woods, and the climate is very agreeable in February, March, and April.

In the *Colony of Natal*, *Port Elizabeth* and *Port Natal* or *Durban* are the only tolerably well-known sea places. The winter climate is distinguished by many dry and sunny days; the summer more by rain and cloud. The winter temperature is about 60°, and the diurnal changes moderate, excepting when the wind suddenly turns to the opposite direction. These localities, however, cannot be regarded as health-resorts, and ought to be used for short stays only, while preparing for the interior.

Australia has many climatic varieties, as must be obvious if we consider the degrees of northern latitude and eastern longitude over which it extends (10° to 39° S.L., and 113° to 154° E.L.), the influence which the Pacific exercises, and the effect which must be produced by the extensive deserts in the interior. The northern shores are tropical, and may be passed over at present; but in the temperate parts, too, the marine climates offer great differences. As we cannot consider the entire coast, we shall restrict ourselves to the principal centres of cultivation, and will begin with *Sydney*, the capital of New South Wales, about 33° 5′ S., and 151° E. Not having any personal experience we shall avail ourselves of the description of a very intelligent traveller in search of health*:—"Sydney is most beautifully situated at the head of the harbour, which is commonly called Port Jackson, and immediately opposite to the entrance of the River Paramatta. The town is built on the side of a hill, which slopes down to the water, and bears some resemblance in its position to the town of Naples. It is a much disputed point amongst travellers which of the three harbours, Port Jackson, the Bay of Naples, or the Harbour of Rio Janeiro, is the most beautiful. I have not seen Rio, but I give the preference to Port Jackson over the Bay of Naples, from the singular variety of its scenery. The harbour is ten miles in length from Sydney to the Heads, and in no part more, I should think, than two miles in breadth." "The shores are thickly wooded to the edge of the water on both sides, and the harbour is fringed with countless little bays separated from one another by narrow promontories, on which are built the picturesque houses of the principal inhabitants of the place, surrounded by bright flowering gardens and orange groves." After such a description it is impossible to give a page of hard and dry though very useful meteorological figures, placed before us by the kindness of Mr. Arthur Wm. Waters, from the publications of the Royal Society of New South Wales. Many readers may like to know Mr. Otter's impression as to the value of the climate in phthisis:—"I have grave doubts whether either place, Sydney or Melbourne, is particularly suitable for invalids who have any serious affection of the lungs; but in cases where persons having a consumptive tendency are obliged to reside out of England, and yet to live in a town in order to follow some occupation, I should certainly recommend Sydney as a place where they would be likely to spend their days as happily and profitably as any one can expect to do who is banished from his native land. It might be well to spend the hottest summer months in one of the high-lying towns in the neighbourhood, or better still in Tasmania or New Zealand; but during the rest of the year I believe that Sydney could not easily be surpassed for a beautiful and healthy climate. The mean temperature of the summer in Sydney is 74° Fahr., and of the winter 55° Fahr., making the mean annual temperature about 65° Fahr. The hot north winds during the summer are trying; and no great invalid should venture out of doors during their prevalence.

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* "Winters Abroad." By R. H. Otter, M.A. John Murray, 1882 (p. 38).

They are succeeded by a wind from the south, which causes a very sudden lowering of the temperature, and which has to be provided against quite as carefully as the hot wind from the north." The mean relative humidity varies during the different months between 67°·5 and 77°·5, is usually lowest from September to December—viz., in spring; highest from March to July—viz., in autumn. The cooler inland localities to which Mr. Otter alludes are probably *Bathurst* and *Goulburn* on the other side of the Blue Mountains; in the latter themselves probably some good summer resorts might be established—for instance, at Mount Victoria.

Melbourne, the capital of the Colony of *Victoria*, has lost much of the reputation which it enjoyed at one time as a health-resort in consumption. While in the beginning of the colonisation there were scarcely any deaths from consumption, they are now nearly in the same proportion as in large towns of England. Melbourne is too windy and dusty, and the changes of temperature are too rapid. Let us hear Mr. Otter's experience:—"The streets being very broad and quite straight, the wind sweeps up the dust in such clouds that on several occasions, when standing on the steps of the club, which is at the top of Collins Street, the principal street in the town, I had great difficulty in distinguishing the lines of the houses on each side of the street at a little distance from where I stood." Spring and autumn are said to be generally very pleasant, but some persons who know the place well, mention that the climate is very uncertain at all times of the year. Mr. Otter recommends some of the suburbs, as Toorah, Richmond, and St. Kilda, to those who are obliged to stay for some time, in preference to the town of Melbourne itself.

South Australia, with the capital of *Adelaide*, is climatically inferior to the neighbourhood of Sydney and to Tasmania for consumptive people.

West Australia, with the towns of *Perth* and *Fremantle*, is, according to the statement of Colonial Surgeon Ferguson, particularly healthy, having a very low mortality—viz., 12 per 1,000. The scantiness of the population has probably a share in this favourable death-rate.

To sum up about the Australian colonies: we should not recommend them in any forms of advanced phthisis, but they may serve as permanent residences to those who are threatened with phthisis and who are obliged to earn their bread, and have a better chance at Sydney than at Colorado, and also to some of those in the early stages of the disease. Tasmania and Sydney, and some of the sheep-farming stations in the interior, deserve, as far as our experience goes, the preference. Furthermore, Tasmania and Sydney may be utilised by those to whom the voyage to Australia has been recommended, and the stay may be extended, according to circumstances, over weeks or months and longer, and may in many cases be advantageously interrupted by tours into the interior or to New Zealand.

B. Inland Climates.

The great varieties of climates comprised in this division might be sub-divided into many groups, according to meteorological characters and therapeutical effects on invalids, but considering the great drawbacks of all classifications, we humbly resign ourselves to two rather primitive sub-divisions:—I. Altitude or Mountain Climates; II. Lowland or Plain Climates.

I. Altitude or Mountain Climates.

The differences between climatic resorts grouped in this sub-division are very great, but the degree of elevation above sea-level or above the surrounding lands produces in the climatic elements some modifications which are common to them, and causes a certain analogy in character.* It is, however, not easy to define which altitude is required to make a place, so to say, a "mountain health-resort." In the plains of North Germany an elevation of 1,500 feet exercises such an influence on the climatic elements that the vegetation offers all the pecularities of a mountain vegetation, while in the Himalayas or the Peruvian Andes an elevation of 8,000 to 12,000 feet is required to produce a similar influence. "On Chimborazo the palms, bananas, and oranges grow at 5,000 feet; at 10,000 feet, Indian corn and wheat; and at 15,000 feet, barley and the more hardy grasses."† The nature of the grass, the flowers, the shrubs, and trees is, perhaps, a better test for the alpine, sub-alpine, or mountain character of a region than any meteorological figures can give, for the nature of the vegetation is the result of the combination of all the influences, the same which act on the human constitution. We may, perhaps, say roughly, that in the northern half of Europe above latitude 50° an elevation of 1,000 to 1,500 feet gives the air the character of mountain air, unless the neighbourhood of the sea modifies the influence, while in the centre of Europe, between 48° and 50°, the elevation required is already greater, say between 1,200 and 2,500 feet, between 46° and 47° between from 2,200 to 3,500 feet, and in or near the tropics from 5,000 to 9,000 feet. In great mountain chains, as the Alps, the Himalayas, and the Andes, greater elevation is required than in isolated mountains or smaller mountain groups, rising from plains away from the sea. Equally difficult is it to say up to which elevation mountain climates can be used for health purposes. In the northern parts of Europe 3,000 feet is probably the limit; in the Alps and Pyrenees elevations up to 6,500 feet possess useful climates. The Hon. Lionel A. Tollemache even goes further, and recommends, in his most interesting article on the Engadine, the Hospice on the Bernina Pass, about 7,650 feet above sea-level, as greatly superior to Pontresina " in point of bracingness ; "* and in the tropical regions 10,000 to 11,000 feet can certainly not be called the upper limit.

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* Mr. A. W. Waters justly says, in a note to a recent communication ("The Deathrate in Langwies, Switzerland," Proc. of the Manchester Lit. and Scient. Soc., October 17th, 1882): "Each of the mountain health-resorts ought, in my opinion, to be separately and thoroughly studied, as I believe that in time we shall see that there are marked differences, and one is suitable for one class of patients, while another may be more suitable for others, and we shall then see that the general classification of mountain health-resorts is to be placed on a level with the remarks of a well-known German doctor (the late Professor Beneke), whose words on climatic questions are often quoted, who makes a comparison of German watering-places with Margate, Brighton, and Torquay, as if all places on the south coast had a similar climate." No one can be more convinced of the correctness of this remark than the author of this paper, who has stated in another place that every attempt at classification of health-resorts appears to him so imperfect that he would prefer an alphabetical arrangement, a dictionary of climatic health-resorts (Klimatotherapie, p. 65); but in a general survey, with a very limited allowance of space, this would be evidently out of place, and thus we are obliged to treat of them in a group, although we know that each of them has separate characters, and after all even the classification of other remedial agents which are more fixed in quality and in quantity has similar defects. In the group of "tonics," for instance, remedies are included which produce very different effects, and even different preparations of the same remedy act very differently, so that the careful consideration of the physician is necessary to see which preparation is required, what is to be the dose and how often, and at what times it is to be taken. The same consideration ought to be applied to climatic resorts.

† "Dictionary of Elevation and Climatic Register of the United States." By J. M. Toner, M.D. New York, 1874 (p. xvii.),

We will now rapidly pass through the principal modifications caused by elevation in the climatic elements.

1. The *atmospheric pressure* decreases in proportion to the increase of elevation above sea-level. At an elevation of 16,000 feet the pressure is only half of that at sea-level; the pressure on our body is, therefore, diminished, and the air which we inhale, and which surrounds us, is proportionately rarefied.

2. The *temperature* decreases, as a rule, with increasing elevation; but this decrease varies according to latitudes, seasons, aspect, and other local influences. In the average, a vertical elevation of about 512 to 556 English feet corresponds to a decrease of 1° Cent., or 1°·8 Fahr. In summer, the decrease of 1° Cent. (1°·8 Fahr.) corresponds to an elevation of about 525 feet, in winter to about 925 feet, from which we learn that the higher elevations are in winter comparatively warmer, and that they have a lesser range between summer and winter temperatures. The periods of the day exercise, likewise, a considerable influence, for during the early afternoon hours, when the valleys are very hot, we have repeatedly found the decrease of temperature in ascending more rapid, for instance, nearly 3° Fahr. for a rise of 700 feet from the Nicolai Valley, near Zermatt; and the very opposite condition in the evening after sunset, when on many occasions we have found the air in the valley cooler than it was 400 feet higher up on the mountain-side. We have mentioned the probable cause of the latter circumstance in the paragraph on Atmospheric Circulation (p. 21).

3. The conditions of *humidity* are rather complicated. The *absolute* moisture of the air is decidedly less in higher than in lower regions, because the cooler air of the mountains is not able to hold so much as the warmer air of low regions; but there is no unanimity of opinions about the *relative* moisture; Gay Lussac, Saussure, Humboldt, Boussingault, and Dove describe it as less in elevated regions; Kaemtz, Bravais, and Martins as higher. Plantamour found the relative humidity of the air at the great St. Bernard Hospice the same as at Geneva. Mr. Steffen found the mean annual relative humidity at Davos in 1876, 72·2°, but it is to be taken into consideration that the humidity of the air in the middle of the day, and during the possible outdoor hours of invalids, is much less than the figure for the whole day indicates. At Denver (41° N. L., 104° W. Long.), in Colorado, the mean relative humidity of the air is only 40° to 50°.† We must further remark that, as pointed out by Steffen,‡ in appreciating the degree

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* "The Upper Engadine." By the Hon. Lionel A. Tollemache. The *Fortnightly Review*, 1876 (p. 364).

† "Transactions of the Colorado Medical Society." Denver, 1878.

‡ "Die Meteorologischen Verhaeltnisse von Davos," &c. Von Wilhelm Steffen. Basel, 1878.

of humidity in its relation to respiration, the temperature of the air must always be taken into account. If the relative humidity is 80°, and the temperature 32° Fahr., the loss of water through respiration is much greater than if, with the same relative moisture, the temperature were 60°, for in both cases it will be exhaled nearly saturated at a temperature of about 80° to 90° Fahr. A similar argument applies also to the air which comes into contact with the outer skin. A very important matter to the invalid is the *moisture of the air indoors*, and especially in his *bedroom*, as he spends a great part of the day in it. Dr. Volland* had already pointed out that the air in the rooms at Davos was very dry, but from recent observations by Mr. Waters† this is the case even to a greater extent than Volland had assumed. "I have found," he says, "this winter that in my room this percentage of the possible moisture has varied from 25° to 35°, as measured with the hair hygrometer, and also with a Reignault's condenser hygrometer. As an example, on January 15th, at 9 A.M., the temperature of the air out of doors was 18° Fahr., and the relative moisture, 60°; showing that the air contained 0·7 grains of moisture in a cubic foot. The total quantity which air at 18° Fahr. can contain is 1·2 grains, whereas at 60° Fahr., the temperature of my room, it could contain 5·8 grains; so that air entering with only 0·7 grains would have only 12° relative humidity; but as there is always evaporation going on in my room from the water-basin, etc., and also some steam entering from the steam stove which heats the room, the percentage of moisture is raised, and on the occasion referred to the amount actually in my room was 27° relative humidity." The great physiological and therapeutical bearing of this subject is self-evident. The *amount of rain* depends greatly on the position of mountains towards warm and moist winds. Thus it is greater on the southern and western slopes of the Alps than on the northern and eastern, and is enormous on the southern slopes of the Himalayas. Some mountain valleys are sheltered from rain by mountain-chains which condense the vapour before it reaches them; such is the case with the Engadine. According to Gasparin and Chaix the quantity of rain increases in the Alps with increasing elevation; but in the mountains of America this does not hold good. The moisture *of the soil* is, as a rule, slight, but this varies much according to local circumstances. *Fogs* are not absent; they are, however, much rarer than in lower regions; but *clouds* are more frequent in certain medium elevations than in low regions, while they are again rarer beyond certain heights, which vary in different mountain-chains; rarer, for instance, in the Alps beyond 5,000 feet.

4. The direct *sun-heat* is, according to the observations made by Mr. Waters‡ at Davos Platz, Dr. Frankland§ at Davos Doerfli, and other authors, much greater at high than in low situations. Dr. Frankland, in a recent most suggestive communication, after having pointed out that the amount of floating matter, consisting "chiefly of watery particles and snow, mingled with

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[*] "Neber Verdunstung und Insolation." Von Dr. Volland. Basel, 1879.

[†] "Preliminary Remarks on Observations made in Davos in the Winter 1881-82." By Arthur Wm. Waters, F.G.S., F.L.S. (Proc. Manch. Lit. & Phil. Soc., 1882).

[‡] "Klimatologische Notizen ü. den Winter ein Hochgebirge." Von Arthur Wm. Waters. Basel, 1871.

[§] "Note on some Winter Thermometric Observations in the Alps." By E. Frankland, F.R.S. (Proceedings of the Royal Society, No. 152, 1874).

small quantities of dust and minute crystals of sea-salt," is the cause of the diminished sun-heat at the sea-shore and in other low regions, and that even with a perfectly clear blue sky, transparent watery vapour in the air is very active in absorbing the least refrangible portion of the solar rays, remarks that "although this floating matter is present at great altitudes, the bulk of it does not rise higher than 5,000 feet above sea-level; and whilst only about one-sixth of the air is below this height, probably much more than one-half of the suspended matter is confined to a lower elevation."* He also points out, as resulting from the same cause, that the sun-heat is comparatively very high immediately after sunrise, and remains high till close to sunset; that the difference, therefore, between the highest midday sun-heat and that of morning and evening is less great than in marine and low inland climates. It follows from this that the difference between sun and shade is greater than in lower regions.

5. The *purity of the air* with regard to organic and inorganic dust is, on the whole, greater; but this depends to some degree on circumstances which vary at different localities. Wherever we find, however great the elevation may be, towns, manufactories, and high roads with much traffic, there we meet with dust; wherever many human beings congregate in relatively narrow rooms, real *purity of air* is out of the question; wherever in an Alpine valley, famed for its health-giving air, too large a number of inns and houses are erected and filled with diseased beings, there the health-giving qualities of the air must sooner or later vanish, and the cures effected become matters of past history. As a rule, we may assume that in scantily-inhabited elevated regions, where there are no decaying vegetable and animal substances, the air is purer, and that this purity to some degree increases with elevation, especially if this elevation goes hand in hand with removal from air-contaminating influences. We find that in higher elevations putrefaction does not so easily occur; that in several Alpine valleys meat can be dried in winter without heat or smoke, and that this dried meat remains good for years. This purity of air manifests itself especially over large snow and ice-fields. We only call to mind that Pasteur found the air over the Mer de Glace free from ferment-like substances, while the air of the village of Chamonix, close by, contained them in large quantity. Up to a certain degree the air of Alpine valleys, covered with snow during four or five months in winter, resembles the glacier air. Dr. Burney Yeo and Dr. Clifford Allbutt have, for such reasons, called the air of these high regions *antiseptic*; perhaps *aseptic—i.e.*, free from sepsis—or fermentation-producing substances would be more appropriate.

6. The *light* in high regions is very intense.

7. The amount of *ozone* is great.

8. The amount of *movement of air* must vary very much in different localities according to their position. There are some very sheltered and some much exposed places at the same elevations. No general rules can be laid down. In the introductory paragraph on Winds we have alluded to the regular mountain and valley winds. It is generally assumed that in summer the movement of air on mountains and in elevated valleys is increased, and that in winter, while the ground is covered

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* "Climate of Town and Country." By Professor Frankland. July, 1882 (p. 40).

with snow, it is much diminished. Extensive observations are wanting, but Mr. Waters made some last winter at Davos with a Robinson's anemometer, and found the wind very slight; the principal movement occurred between 1 and 3 p.m., and was a valley wind.* Different localities vary very much in this respect.

The *physiological effects* of mountain air on the constitution are very complicated and not yet sufficiently investigated. We can only briefly discuss the manner in which some of the principal organs and functions appear to be influenced.

1. The *skin* receives more blood in consequence of diminution of atmospheric pressure and increase of sun-heat; the nutrition of the whole organ becomes improved, and, hence, the tendency to chills and colds diminished.

2. The contractions of the *heart* become, on removal from low to high elevation at first, as a rule, increased in frequency; but after a short stay they return in general to their accustomed number, but become increased in force. The statement that there is a tendency to hemorrhage is referable only to much higher elevations than those used for treatment by climate.

3. The conditions of *respiration* have given rise to various controversies. It has been stated that the number of inspirations must be increased, because the rarefied air does not contain so much oxygen in the same volume as in lower regions; but this seems incorrect. In our own observations on 48 persons in good or moderate health, it was in the majority of cases during the first days after arrival in elevations varying from 4,000 to 8,000 feet increased, but after a few days it was the same as in their homes, with few exceptions, but the inspirations appeared to be deeper. Some authors think that the body receives an insufficient quantity of oxygen at high elevations, but this is very doubtful in healthy persons, for the well-known experiments of Drs. Frankland and Tyndall on the burning of candles on the top of Mont Blanc and at Chamonix show that, although the light-giving power of the flame was much diminished on the top of Mont Blanc, the quantity of stearine consumed, or, in other words, the energy of combustion, was almost precisely the same as below. This result is ascribed to the greater mobility of atoms in the rarefied air "making atonement for the smallness of their number by the promptness of their action." From this experience we are obliged to conclude that at the elevations used for health purposes the amount of oxygen in the air is quite sufficient for the maintenance of the physiological functions of respiration and change of tissue.

As to the percentage of *carbonic acid* in the air expired, Dr. Marcet† found it rising from the lower to the higher regions; at Teneriffe it rose from 4·1 per cent. at the seaside to 4·9 per cent at 11,945 feet, while in the Alps the proportion varied from 3·8 per cent. at 1,230 feet to 4·7 per cent at 9,403 feet. He also found the amounts of *water expired* from the lungs and air passages considerably increased in higher elevations. Dr. Marcet argues from this, as we ourselves have done on several occasions,‡ that this increased evaporation from the lungs must cause a corresponding loss of heat, or cooling of the lungs and air passages, which may exercise a curative influence in ulcerative and inflammatory processes of the respiratory organs. It is probable, as Waldenburg, Boner, and others assume, that more blood flows to the lungs in higher regions, partly from the diminution of atmospheric pressure, partly in consequence of the increased evaporation, and that an improvement of the nutrition of the lungs is the effect of this increased efflux of blood. Many observers have noticed an increase in the size (circumference) of the thorax as the result of long stay in high elevations. Dr. C. T. Williams has paid much attention to this subject, and has shown it graphically in a paper before the International Medical Congress.

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* *loc. cit.*, p. 26.

† "A Summary of an Inquiry into the Functions of Respiration at various Altitudes on the Island and Peak of Teneriffe." By William Marcet, M.D., F.R.S. Proc. Roy. Soc., 1879.

‡ "On the Curative Effects of Baths and Waters." By Dr. Julius Braun. Edited by Hermann Weber, M.D. Smith, Elder, & Co., 1875. Editor's note, p. 41.

4. *Increase of Appetite* is in the majority of persons, as well in health and disease, one of the earliest, though by no means constant, effects. The degree of elevation at which it occurs varies in different individuals; in some it is most marked at elevations from 2,000 to 4,000 feet, and disappears, or shows the reverse, above 5,000 feet; in others it only manifests itself above 3,500 feet, and is most marked between 4,500 and 7,000 feet. In some, and these are the majority, it is most marked in winter; in others almost only in summer; in some the appetite remains increased during their whole stay at high elevations, while in others it recedes after a few weeks or months to the individual average. More or less intimately connected with this point is the *improvement* in the *sanguification*, in the *general nutrition* of the body, and in the energy of the *muscular* and *nervous system;* effects which show themselves in the better colour, in greater regularity of functions, in *gain of weight*, in greater firmness of muscles and ability to take exercise, in improved mental power and exhilaration.

5. The influence *on sleep* is by no means uniform. The majority of persons sleep better at moderate elevations—viz., 3,000 up to 5,000 and 6,000 feet. In others, however, sleep is at first often interrupted or disturbed by dreams; generally this disappears after a week or more, but in some individuals sleeplessness remains and obliges them to descend. It must, however, be remarked that the *quality of sleep* varies much at different localities in different people, and that a shorter period of sleep in high elevations seems to most people an equivalent to a longer period in lower regions—six hours instead of eight hours below. We often meet with people on whom mountain air seems to act as a soporific, especially amongst literary men. It is possible, as Professor Binz suggests, that the larger amount of ozone in mountain air has a share in this effect.*

The difference in the action of the various climates included in this sub-division is very great, according to elevation, degree of latitude, aspect, configuration, &c. Only in general terms we may say that the *character of mountain climates is stimulating* and *tonic*, *but that the constitution* must *possess a certain amount* of *energy* and power of accommodation, in *order to be benefited.* Amongst the most frequent conditions which are advantageously influenced by mountain climates we may mention mental and bodily exhaustion and atony of various functions from over-work, town air, and town life; imperfect convalescence after acute diseases; weakness of the skin with profuse perspiration; chronic catarrh of the throat and air passages with much secretion; changes produced by malarious affections; Indian cachexia, climacteric conditions, both those of tardy and difficult development, and also those of the retrogressive periods in men as well as women; imperfect expansion of the chest; tendency to phthisis, and the first stages of chronic phthisis. Scrofulous affections are likewise benefited by mountain climates, but in the majority of cases marine climates deserve the preference. *Asthma* has always a degree of uncertainty as to the influences which are likely to be beneficial or injurious, until a trial has been made; but in so-called nervous and also bronchial asthma, uncomplicated with disease of the heart, emphysema, or bronchial dilatation, long residence in elevated regions is more frequently beneficial than that in other climates; this is principally the case in children and younger people—much more rarely above the middle age.

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* Ozonisirte Luft, ein shlafmachendes Gas. Von C. Binz in Bonn. Berliner Klin Wocherschrift, 1882, Nos. 1 and 2.

Dr. Ludwig* mentions the following conditions as *not suitable*:—1. Heart disease; fatty degeneration; dilatation and atrophy of the left ventricle; valvular diseases. 2. Conditions which predispose to apoplexy; aneurism and atheroma of arteries. 3. Emphysema, if advanced and accompanied with bronchitis. 4. Laryngeal and intestinal tuberculosis. 5. Convalescence from dysentery. 6. Disposition to acute rheumatism. 7. Disposition to acute inflammation of the tonsils, the pharynx, or larynx.

This list is of great practical value, not only with regard to the Engadine, but also to the majority of other Alpine climates. We will only add that *slight* elevations—viz., 1,000 to 2,000 feet, if the ground is fairly level—are often specially suitable to the heart affections above-mentioned; while *higher* elevations—viz., 3,000 to 4,000 feet—rarely are so. Epilepsy and mental aberration with excitement ought not to be sent to high elevations. Great degrees of constitutional weakness, with inability to bear cold, wind, or frequent changes of temperature are likewise unsuitable for long residence in high regions, though short stays in summer and autumn are often beneficial. Very advanced age and early youth are more adapted to warm seaside localities than to high mountains.

It would be out of place to enter into details with regard to these different conditions, but the treatment of *consumption* by residence in elevated regions has become so much a matter of general interest that we cannot avoid a short discussion of it. The ancient physicians occasionally advised mountain places in preference to sea-voyages, or to marine and low-lying localities; but their ideas of elevated regions do not exactly correspond with ours; thus *Castellamare*—the ancient *Stabiæ*—recommended by Galen, and *Lettere*—probably the "Mons Lactis" of Cassiodorus—about six miles from Castellamare, are only a few hundred feet above sea-level. From the late Dr. Archibald Smith,† however, we know that on the coast of Peru, especially at *Lima*, where phthisis, usually attended with more or less hæmoptysis, is one of the most common pulmonary affections, it is regarded "as a disease almost certainly curable, if taken in time, by removing the coast patient so attacked to the open inland valley of Jauja, which runs from ten to eleven thousand feet above sea-level." We do not know how far this knowledge dates back, but Archibald Smith says :—"This fact has been known and acted upon from time immemorial by the native inhabitants and physicians." In Europe, it is not thirty years since Dr. Brehmer[*] commenced, at *Goerbersdorf*, in Silesia, to treat phthisis by mountain air, assisted, however, by cold douches, diet, and exercise, under very strict medical supervision. The comparatively favourable results obtained led to the fairly successful trials at Davos, St. Moritz, Falkenstein, and other places. In England the subject was at first not received with favour, in spite of some papers by the author of this article, written without theory and prejudice;[†] and a very instructive meteorological paper by Mr. A. W. Waters,[‡] a communication on the elevated health-resorts of the southern hemisphere, by Dr. Symes Thompson,[§] Dr. Frankland's researches on winter temperature in the Alps, already mentioned, and the active support of Dr. C. T. Williams. During the last five years the public mind, however, seems to have undergone a rapid change, at least in favour of Davos, after an enthusiastic paper on the climate of Davos, by Dr. Clifford Allbutt,[||] in October, 1877, and a highly attractive, in some respects poetical, but practically true, description of the winter at Davos, by Mr. J. A. Symonds,[¶] and a small anonymous book, "Davos Platz, a new Alpine Resort for Sick and Sound, in Summer and Winter." There are many other communications in German, French, and English, which we have no space to mention at this place. There are many medical men still who think with horror of what they call "startling, quasi-sensational novelty in climatic therapeutics" of treating consumption in the rough and changeable climates of the European Alps; while there are others who think that the Alpine climates offer the only chance for those attacked or threatened with consumption. We venture to think that both might with advantage to their patients somewhat modify their views.

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* Das Oberengadin in seinem Einfluss auf Gesundheit und Leben. Von Dr. J. M. Ludwig. Gekrönte Preiss-schrift, 1877 (p. 129).

† "Climate of the Swiss Alps and the Peruvian Andes compared." By Archibald Smith, M.D. *Dublin Quarterly Journal of Med. Science*, May, 1866. See also *Edin. Med. and Surg. Journal*, No. 144, and *Brit. and For. Med. Chir. Rev.*, No. xxxvi., Oct. 1856.

The *opponents of Alpine climates* think that "the cold and snow prevent the invalid from being out in the open air, and oblige him to remain in close, unventilated rooms;" while in reality the majority of our patients who have spent several winters at warmer places, either on the Riviera, or at Algiers, or at Pau, and several at Davos or St. Moritz, have found that the number of days on which they could walk and sit in the open air was greatly in favour of the Alpine resorts. The opponents further say that patients often "catch cold," and are then confined to their beds and rooms for many weeks by what may be called *intercurrent acute diseases*, as inflammations of the throat and bronchi, of the lungs and pleura, rheumatism and rheumatic fever. We have taken the trouble to examine the days of confinement in a large number of as far as possible similar cases at both classes of localities, and find that the intercurrent diseases are much less frequent in the

[*] "Die chronische Lunguischwindsucht." Von Dr. Hermann Brehmer. Berlin, 1857.

[†] "On the Influence of Alpine Climates in Pulmonary Consumption," *Brit. Med. Journal*, 1867, Vol. II., and "Treatment of Phthisis by prolonged Residence in Elevated Regions," *Med. Chir. Trans.*, Vol. LII., 1869.

[‡] "Klimatologische Notigen uber den Winter ein Hochgibuge." Von Arthur Wm. Waters. Basel, 1871.

[§] *Med. Chir. Trans.*, 1873.

[||] On Davos as a Health Resort." The *Lancet*, 1867, Oct. 20th and Oct. 27th, followed by other papers in the *Lancet* in June, 1878, and July, 1879.

[¶] Davos in Winter." By John Addington Symonds. *The Fortnightly Review*, July, 1878.

Alpine resorts than in warmer southern regions. Again, it is stated by the opponents that *hemorrhage* is more frequent in high places; but the testimony of all those who judge not from theory but from *experience*, shows that hemorrhage, though it does occur everywhere in consumption, is less frequent in high elevations. We have quoted above the testimony of Archibald Smith, and we may refer to publications of Drs. Denison and Solly at Colorado, and this is in accordance with the experience of the physicians at Davos, St. Moritz, Goerbersdorf, and Falkenstein, as also Dr. C. T. Williams and the writer. Many of the attacks of hemorrhage occurring at Alpine resorts, though not all, are attributable to imprudence in exercise and to exposure. The idea that the air in rooms without open fire-places in the cold Alpine winters *must* be bad is likewise erroneous. I will give the experience of a very intelligent observer, who has tried many climates :—" I formerly pointed out how much patients could be out of doors in Davos, and extended experience convinces me that they enjoy, in favourable winters, more fresh air out of doors than in warmer resorts on the Riviera; but this time I will not stop here, for what is also very important, we can enjoy fresh air more in our rooms than in most warm resorts. No doubt it will at first sight seem strange that consumptive patients should sleep with their windows open when the temperature is 10°, 20°, or 30° Fahr., or even more, below freezing-point; but consideration will show that it is only reasonable and what we might expect, for with the low temperature, the absolute amount of moisture, even were the air saturated, could be but small. Now, the cold air entering, the room is rapidly warmed, and as the amount of moisture it contains is a very small proportion of what the air at the room temperature can contain, this causes the relative moisture of the room to be very low."* The night temperature in the bedroom of Mr. Waters during the winter 1881-82 was about 60° Fahr., the relative humidity 25° to 35°.

However different the views of different men may be, almost all will agree that pure air is essential in the treatment of phthisis, and theory as well as experiment demonstrate that Alpine air, in scantily-populated hygienic localities, especially in winter when the ground is covered with snow and ice, is much more pure than the air of the majority of low-lying districts, although there are amongst the latter localities which enjoy a satisfactory amount of purity. We quite agree with Dr. Clifford Allbutt that in phthisis we have to deal with lesions which are apt to lead to impure ulcers and chronic blood-poisoning, and that we must endeavour to treat them like open wounds. We cannot easily apply antiseptics, but we must endeavour to prevent the access of impure air, by placing the patient in the purest possible air. Now mountain-air possesses, in addition to a fair amount of purity, the qualities of *dryness* and *low temperature*, by which the *aseptic* influence is considerably assisted. We have mentioned before that in mountain climates the surface of the lungs parts with a large amount of fluid, and that this process of increased evaporation is connected with *cooling*, that we have, therefore, in addition to the help of the pure air, two agencies important in the treatment of wounds and inflammations, *dryness* and *cold*. This is not yet all; as soon as exercise is taken, the breathing is accelerated, and thus the lungs are more *ventilated.* Furthermore, the lungs become fuller with blood, and the sores and ulcers are, therefore, *compressed,* which is still more the case when the tissue around them becomes inflated with air, partly by recovery of collapsed tissue round the diseased part, partly by a process of emphysema, which is almost always found round pulmonary cicatrices. We have, therefore, in high elevations :—*pure air, dryness, cold, ventilation,* and *compression,* as *local* means of treatment ; we have, besides, the *stillness of the air* and the *great sun-heat* on many fine days permitting open-air exercise, and sitting in the open air ; and we have in favourable cases the increased appetite, the disappearance of night perspiration and fever, the improvement of the whole constitution, which is most important in a disease that is constitutional as well as local. We can, therefore, not hesitate to say that in a great many cases of phthisis and phthisical tendency, long residence in certain mountain climates is useful. Prominent amongst these conditions are :—1, tendency to phthisis, inherited or otherwise ; 2, chronic catarrhal affections of the apex, or upper portion, of one or both lungs, without or with affection of the lung tissue itself (catarrhal pneumonia) ; 3, chronic bronchial catarrh of the lower lobes, with much secretion in young people, or, at all events, not old people ; 4, remains of pneumonia ; 5, remains of pleuritic affections, with and without exudation ; 6, so-called caseous deposits, resulting from catarrhal, pneumonic, or pleuritic affections ; 7, the early stages of phthisis in one or both lungs, with limited infiltration, with or without cavities.

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* " Preliminary Remarks and Observations made in Davos in the Winter 1881-82." By Arthur Wm. Waters, Proc. Manch. Lit. and Phil. Soc., 1882.

These conditions may occur in individuals to whom well-selected mountain climates offer more than any other climates ; they may occur in such persons who, with judicious management, may recover as well in marine or not elevated dry inland climates as in mountain climates ; or in such to whom the latter offer less than one of the former ; or to whom mountain climates are absolutely injurious. It is impossible to give short rules by which the one class can be distinguished from the other ; it must be left to the physician to weigh the advantages and disadvantages in every individual case ; but some of the conditions which are not suited to mountain climates have been already mentioned (p. 66.) We must add that *phthisis,* even in the earliest stage, ought to be excluded from European Alpine climates, when it occurs in so-called *erethic* constitutions, in persons with an irritable heart and circulation, with a constantly rapid pulse, whom the slightest derangement makes feverish, who are unable to bear cold and the slightest changes of temperature. Even Dr. Spengler, who formerly considered the climate of Davos, in all early cases, as curative, is now against the trial in such cases, and Drs. Unger, Volland, and Peters, at Davos, and Drs. Berry and Ludwig in the Engadine, are of the same opinion. Further, patients with *advanced* and *still progressive* phthisis ought to avoid Alpine climates. It may be difficult to promise them a cure anywhere, but at the warmer health-resorts of the Rivieras, Algiers, or Madeira, they have more comfort, while others, if they knew their condition, would prefer the sheltered localities near their own homes and friends. The same ought to be said to all those whose condition, if they were to go to the Alps, would be likely to keep them, during weeks and months together, indoors.

Duration of the Stay at Mountain Health-Resorts.—The time during which invalids ought to stay in mountain climates differs greatly according to the nature of the case; from a few months, when only strengthening of the nervous system or the whole constitution is desired, to two or three years, possibly with interruptions, when we have to deal with the commencement of phthisis, or to even a longer period of time, when the disease has already more deeply affected the lungs and the system.

Season of the Year.—Mountain climates may be resorted to during the whole year, but the best times are winter and summer. The Alpine health-resorts for consumption offer the greatest advantages *in winter* for reasons previously given, and patients ought to arrive, if possible, in the earlier part of September, in order to become acclimatised before the period of transition, from autumn to winter, which may be expected towards the end of October, and which is often very trying to delicate persons. Towards the end of November winter has generally set in, and, as a rule, the valleys remain covered with snow till the beginning of March. During this period of *real winter* the number of perfectly clear days, with considerable cold in the shade and great heat in the sun, so that the invalid can during many hours sit, walk, skate, or drive in the sun, is very great, and the days on which he is entirely confined to the house are very few. It is difficult to decide what to do when snow-melting begins. It is the custom to send invalids away, because the climate is in spring rather more changeable than usual; there is more wind, and the ground is often damp, so that throat colds, or relaxed throats, are not rare. The doctors are sorely in want of a holiday, and hotel proprietors and shopkeepers wish to cleanse their premises, and make their arrangements for the summer season. Invalids themselves, naturally enough, long for a change to warmer regions, cheerful with the earlier spring flowers, such as the Italian lakes, or Venice, or the Riviera. So the exodus in spring agrees with the inclinations and convenience of all people, but the invalids often fall ill with the changes to these warmer, damper, more relaxing regions, and often lose in a few weeks what they have gained during the whole winter.

Mr. Waters, who combines so much intelligence with personal experience, is of opinion that the invalids ought to leave Davos in March, and go to Lugano. The latter is a fairly satisfactory place; but there, too, the weather is often very trying; and from the experience of our own patients we are obliged to infer that, if all cases are taken together, the risk of going in March to Italy, or Switzerland, or Germany, is at least quite as great as that of remaining at Davos or St. Moritz. Every case, in this matter too, ought to be considered individually, for there are, no doubt, many to whom a change is a necessity, and many who run much less risk in staying, and who with reasonable precautions can fairly keep their health, as experience has abundantly proved.

The *summer* in Alpine health-resorts offers likewise advantages to consumptive invalids. The heat is comparatively moderate; the mornings and evenings, at all events, are fresh; the air is pure, if localities free from dust are selected; and even the weakest persons are able to spend many hours in the open air if they rest in hammocks suspended between trees. Those, however, to whom a change is useful, can move with much less danger in summer, and can find good localities in wooded parts of medium elevation in Switzerland, the Black Forest, the Tyrol, or Italy; or can go, as Mr. Lionel A. Tollemache* would probably, with good reason, suggest, to still higher places in the Alps, in the same way as the invalids at Colorado often camp during the summer months in the higher regions of the Rocky Mountains; and many of the fairly strong English invalids can, with due care, go to the east or south-east coasts of England, or to cooler inland places as Ilkley, the Yorkshire and Scotch Moors, Braemar, Harrogate, the neighbourhoods of Leith Hill, Haslemere, &c.

We will now proceed to a short account of some of the principal mountain health-resorts of Europe, and a few places in other parts of the world; and will begin with the localities specially used in the treatment of pulmonary consumption and allied conditions.

Davos first claims our attention. There is, perhaps, scarcely another place which has gained a great reputation so rapidly. When we directed attention to it in 1867,† there were only two small village inns; now, large hotels are spread almost continuously over a whole mile. The *Valley of Davos* is a broad Alpine valley parallel to the Engadine, but in the opposite direction—viz., from N.N.E. to S.S.W. The sun has access during the greater part of the day. It is by the position of the mountains remarkably well sheltered, not only from the cold winds, but to a great degree, though not entirely, from the dreaded, relaxing, south-west wind (Föhn), so that the air is, as a rule, rather still, especially in winter. We have pointed out in the general remarks the large number of sunny days, the high degrees of sun-heat, the purity and the dryness of the air out of doors, and the remarkable dryness within the rooms, as well as the other general meteorological features. For more detailed descriptions we refer to the well-known communications by Waters, Spengler, Frankland, Unger, Clifford Allbutt, Addington Symonds, C. T. Williams, Burney Yeo, Peters, and others, to which several other English, a considerable number of German, and a few French works might be added. We have already mentioned the class of cases suitable and those which are not suitable, and have made a few remarks about the best season, the duration of the stay, the arrival and departure. As in every climatic resort, so at the mountain resorts for phthisis, it is especially necessary that the invalid should place himself immediately on arrival under the guidance of one of the physicians, and should strictly follow his advice. It is of the greatest importance to lung invalids to inhabit sunny rooms only, and to learn how to keep the air in them pure and moderately cool. Crowded rooms ought to be avoided, and theatres and concerts ought to be only exceptionally permitted to those who are really ill. There is so much truth in Dr. MacCormac's views on the causes of consumption that they ought to be more widely known, and invalids in mountain health-resorts ought to consider "*that no elevation, air pre-breathed being again breathed, yields immunity from phthisis.*"‡

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* "The Upper Engadine." By the Hon. Lionel A. Tollemache. *The Fortnightly Review*, March, 1876 (p. 363).

† "On the Influence of the Alpine Climate in Consumption." *Brit. Med. Jour.*, 1867. Vol. II. (p. 58).

‡ "Consumption and the Breath Re-breathed." By Henry MacCormac, M.D. Longmans, 1872 (p. 39).

The principal health-resort of the Davos Valley is *Davos Platz;* but *Davos Dörfli,* a mile higher up in the valley, has very similar climatic qualities, and perfectly fair accommodation. Lower down in the valley is *Davos Frauenkirch,* which is not quite so well situated, but may be resorted to by some invalids wishing for greater solitude.

It is impossible to leave the Davos Valley without alluding to the fact that there is grave danger that the great reputation of the place may lead to its destruction. We have ourselves been struck with this fear at our last visit in 1881, and the note of warning sounded by Mr. J. Addington Symonds, in his "Drawbacks to Alpine Sunshine," appears to us to have come not a moment too soon. 1, "There is now a perceptible cloud of smoke," he says, "always hanging over the valley, shifting with the wind, but not escaping, and thickening the air to a considerable extent;" this smoke arises mainly from chimneys; but it reminds one of the breath of many hundreds of consumptive patients aggregated at close quarters; 2, "the houses, which have sprung up like mushrooms, are built with so little attention to the requirements of a sanatorium that the main promenade is more than half in shadow;" 3, "the drainage of the whole place is infamous;" and, 4, "the social amusements of a watering-place have been greatly developed. Dances, concerts, theatres, bazaars, private theatricals, pic-nics, are multiplied. Some entertainments of the sort are, no doubt, not only necessary, but also beneficial. Yet it must be remembered that the peculiar severity of Alpine winters, the peculiar conditions under which the consumptive people meet together here, crowded into rooms artificially heated with stoves, render all but the simplest forms of social gathering very dangerous." It must have been a hard task for the poetical author of "Davos in Winter," which breathes harmony, thus to write about the disturbing elements which are apt to creep up wherever men congregate, unless the greatest vigilance is exercised. But justice demanded it. The drainage question, we are happy to say, is being vigorously grappled with by the community, but the smoke nuisance will probably not be quite so easy a matter to deal with. Dr. Symes Thompson, just returned from a tour to the Alpine winter resorts, writes to us on January 17th, 1883, "Davos is too full, and the smoke hangs over it all day." As it is not easy to find many places like Davos, it would be a great calamity if it were to be ruined. It is therefore a duty incumbent upon all those who can exercise any influence, to use it in promoting the improvement of the sanitary arrangements and in preventing the further building of hotels and *pensions.*

St. Moritz Village, in the Upper Engadine, next demands our attention. It is so often resorted to in summer by English health-seekers, and so well known by the descriptions of Dr. Burney Yeo, Mr. Lionel A. Tollemache, Dr. Ludwig, and others, that it is not necessary to give a description. *St. Moritz Kulm,* the only house open to winter guests at present, lies over 6,000 feet above sea-level, on the southern slope of the Piz Nair, by which it is sheltered from cold winds, and about 260 feet above the lake of St. Moritz. The climatic conditions are rather similar to those of Davos, the shade temperature in winter slightly lower, but the sun temperature is equally high, as was shown first by the meteorological observations which Mr. F. Townsend and Mr. Greathead kindly made for the writer during the winters 1868-71, and which have been corroborated since at different stations of the Engadine. Whoever wishes for accurate information on the subject will find it in Dr. Ludwig's successful prize essay. There is much wind from the Maloja in summer during the middle hours of the day and early afternoon, but comparatively little in winter. Mr. Waters, however, who is engaged with observations on this point, finds that there is more wind at St. Moritz than at Davos. The number of clear days is very great; there is excellent skating, and the opportunity for sleighing is greater than at Davos. Between 1867 and 1872 many consumptive invalids spent one or several winters at St. Moritz and Samaden, and the results on those whom we had the opportunity of observing, together with Dr. Berry, of St. Moritz, were satisfactory, although the arrangements of the hotel for winter residence were imperfect through the coldness of the hall and passages. This latter circumstance was the reason why Davos was in the following years recommended in preference to St. Moritz. As the arrangements at the Kulm hotel are now good, the place is likely to prove again beneficial to many, and thus to save Davos from becoming overcrowded and ultimately ruined. Very delicate cases of phthisis, however, we should not send to St. Moritz, on account of the larger amount of wind; on the other hand, tolerably robust, chronic cases, are likely to do even better than at Davos; and invalids suffering from general depression of the nervous system, or malarious affections, will find more scope for excursions, and a still more bracing air. We will conclude our notice by a remark of the same physician, from whose letter of the 17th of January we have already given a quotation :—"St. Moritz is this year in perfect order; nearly 100 people are at the "Kulm," but it is not overcrowded, and the people are most happy, the food good, and the rooms well warmed."

Samaden, 5,600 feet above sea-level, the capital of the upper Engadine, has similar climatic conditions, and good inns. English families have repeatedly spent whole winters at Samaden, and have spoken highly of Franconi's Hotel, Bernina. Its bracing summer climate is well known. *Pontresina* (5,900 feet) has somewhat more sun than St. Moritz during November, December, and January, and would probably make a good winter resort, but the hotel proprietors are as yet not in favour of receiving winter guests. The great attractions and the bracing qualities of Pontresina during summer are too well known to require comment. We have already mentioned that the *Bernina Hospiz* (7,650 feet), so much recommended by Mr. Tollemache, may serve as a thoroughly bracing place for a few weeks in summer to those who bear high elevations. *Celerina*, a village between St. Moritz and Pontresina, seems to have more sun than any of the better known places of the Engadine, being in sunshine even on the 15th December for seven hours and twenty minutes; but we have no experience about the amount of air movement. There are several other localities in the Upper Engadine which could be rendered available as winter health-resorts; for instance, some situations near *Campfer*: but the present favourite inns for summer guests are too near the dusty high road; a hotel for invalids ought to be placed as far as possible away from the latter, in the sunniest position, near pine woods. *Sils-Maria* (nearly 5,900 feet) has, perhaps, with regard to natural beauty, the finest situation in the Engadine, is well sheltered from wind, and has pine woods in its immediate neighbourhood. It is, no doubt, one of the best summer resorts, and is a good place of change to many winter guests from Davos, St. Moritz, and the Rivieras; but it would possibly also be a good winter resort. Sils-Maria has the sun during the shortest days a few minutes longer than St. Moritz; in March, St. Moritz has it longer; and in summer Sils-Maria has more shade from mountains and woods. The villages of *Sils* and *Silvaplana*, and the *Maloja Pass*, are too much exposed for winter guests, but may serve as summer resorts, especially the Hotel Pension Beauséjour at *Sils Baselgia. Zuz* (5,548 feet), on the way from the Upper to the Lower Engadine, has a sunny and fairly-sheltered situation, and may some day serve as a winter resort, in the same way as it does now in summer.

In the *Lower Engadine* there are, likewise, several places whose position renders them suitable as health-resorts, though the accommodation is as yet limited. *Guarda* (5,400 feet) above Lavin, beautifully situated for summer; *Fettan* (5,400 feet) above Ardetz, and some localities between this place and *Schuls* for summer as well as winter; the well-known watering places, *Schuls* (3,970 feet), *Vulpera* (4,180 feet), and *Tarasp* (3,890 feet), which are visited on account of their saline and chalybeate springs, owe part of their influence to the mountain climate.

In looking for an outlet to Davos, Mr. A. W. Waters directs attention to *Arosa*, a beautifully-situated village in a valley to the south of the Schanfigg. Mr. Waters thinks it well sheltered from wind. The death-rate of Langwies, the principal place of the Schanfigg, which he publishes, is favourable, especially "during the years of youth—viz., the most fatal time for lung disease." *Wiesen* (4,770 feet), in the lower part of the Davos valley, has been likewise repeatedly suggested as a winter resort, and, amongst others, by Mr. Symonds. It lies on a sunny slope of a high mountain — Rothornstock — by which it is sheltered from N. and N.E., at a considerable elevation above the Landwasser. It is already a favourite place for summer invalids, and evidently offers advantages for winter. A doubtful point is whether it is too much exposed to the south wind, which is somewhat relaxing; and another point is, whether the winter may not be too mild, so that the snow sometimes may melt away in the midst of winter, leaving a damp surface.

The canton of Grisons possesses, in addition to the Engadine and the Davos valley, some other valuable localities. The *Val Bregaglia* (the *Prægallia* of the Romans, *Bergell* of the Germans), between the Engadine and Chiavenna in Italy, has two charming places specially adapted for autumn and spring—viz., *Soglio* (3,570 feet), a sunny spot, with the Hotel Giovanoli, in an old mansion of the Salis family, and *Promontogno* (2,690 feet), with the Hotel Bregaglia, or "Bergellerhoff." In the Val Poschiavo, between the Engadine and the Valtellina, lies *Le Prese* (3,100 feet), near the Lake of Poschiavo, a sulphur spa and climatic resort. These three localities are also useful as transition stages between the Engadine and Italy.

In the *Prättigau*, the valley between Davos and the Rhine valley, *Klosters* (3,950 feet) possesses a bracing climate and fair Pensions; and from lower down in the valley, a carriage road leads to *Seewis* (2,986 feet), with mild climate and fine

* "The Death-rate of Langwies." Proc. of the Manch. Lit. and Phil. Soc. Oct. 17, 1883.

walks. On the passage from Küblis to Schruns, in a beautiful position, lies the almost unknown Hotel-Pension *Salzfluh* (5,870 feet). To those who are satisfied with plain fare and simple accommodation, the chalybeate spa of *Fideris* (3,640 feet) may serve as a useful summer resort. On the way from Coire to Tiefenkasten and St. Moritz we ought to mention *Churwalden* (nearly 4,000 feet), with fair inns in proximity to woods; *Parpan* (4,940 feet), in a more open situation, with less shelter and homely accommodation; and the sulphur-baths of *Alveneu* (3,165 feet), in a green valley for those who wish to combine a mild mountain climate with a course of waters and baths.

In another direction from Coire, at the entrance to the Via Mala, *Thusis* (2,450 feet) has beautiful walks, and forms an intermediate station between the Engadine or Davos and lower places; higher up on the Splügen road is *Andeer* (3,210 feet), and further on the route to Bellinzona, the old-established, but, compared to St. Moritz, still rather homely, iron spa of *San Bernadino* (5,335 feet), on the Italian side of the Pass. . In a south-western direction from Coire, on the Oberalp route, we must name a secluded spot, the *Flimser Waldhäuser* (about 3,620 feet), with a new and well-arranged hotel, the "Kurhaus Waldhaus-Flims," and a smaller one, "Hotel Segnes," situated in an extensive pine forest, by which the climate is rendered mild and rather windless, and obtains, in addition, the modifications due to the exhalations of the pines. There are few other localities in Switzerland with so many beautiful and varied walks through pine woods, accommodated to the varying strength of different people. A lake with bathing and boating accommodation, 350 feet below the "Kurhaus," adds to the advantages of this place, which is nearly unknown in England, but much appreciated in Germany and Switzerland. The place is remarkably adapted to those requiring seclusion, rest in the open air, without wind and much light; very different from the Engadine or the Rigi. After fatiguing courses of waters, such as Tarasp, Carlsbad, Franzensbad, Marienbad, such a locality is particularly suitable, but unfortunately in July and August there is seldom room, unless ordered long before. In June and the end of August it is less difficult to obtain accommodation. On the same route, further towards the Oberalp, *Disentis* (3,770 feet), near the historical old abbey, invites, likewise, summer guests in the "Hotel Disentis," under the direction of a medical man (Dr. Condrau). Although the elevation is nearly the same as that of the Flimser Waldhäuser, the climate is very different. Disentis is exposed to sun and wind, has little shade, and is decidedly stimulating, while the climate of the Waldhäuser is rather soothing, but not relaxing. In the arrangements at the Hotel Disentis, English habits are specially consulted. The last place we mention in the Grisons, which possess many other good localities besides those named, is *Piora* (over 6,000 feet), between Airolo and the Lukmanier Pass on the southern slope of a hill, protected from cold winds, with fine pine woods in the neighbourhood, not far from the Lake Ritom.

The *Canton of Valais* offers more to the mountaineer than to the delicate health seeker. The *Riffell Hotel* and *Zermatt*, for instance, cannot be called health resorts, but the *Bellalp* (6,730 feet) above Brieg, near the Aletsch glacier, in one of the grandest positions, is sunny, exhilarating, and bracing, and the *Riederalp*

(6,390 feet) on the other side of the glacier, more homely, has a similar climate; both are on southern slopes with abundance of air; the Hotel *Eggischhorn* is not quite so well situated. *Vissoye*, (4,000 feet), and *Zinal* (5,500 feet), both in the Val d'Anniviers, are somewhat less bracing, from their positions in deep valleys; the same is the case with *Evolena* (4,520 feet) in the Val d'Hérens, from where the two small but fair glacier inns—*Ferpècle* and *Arolla*—are easily reached. *Loèche-les-Bains* (4,600 feet), renowned for its hot lime-water springs, may also be used as a climatic resort of fairly bracing characters. The chalybeate spa of *Morgins* (4,600 feet), near the Val d'Illiez, is little known out of Switzerland, but combines a tonic climate with tonic waters; while *Champery* (3,390 feet), at the foot of the Dent du Midi, has a rather mild climate, with beautiful woods and flowers.

The *Canton de Vaud*, or *Waadt*, possesses none of the highest health-resorts, but a number of very useful and beautiful places in medium elevation, many of them with grand views. According to aspect and elevation they possess more or less of the moderately tonic character, none being highly stimulating; those facing south being specially well adapted to delicate persons with limited power. The early summer and the commencement of autumn are the best periods; the middle of summer being suitable only to those who are fond of heat. *Villars*, near Ollon (4,000 feet) above Aigle, has a particularly fine position and good accommodation. The *Hôtel des Diablerets* (3,800 feet) at *Plan des Iles* near Ormond Dessus; the *Pension des Hirondelles* at *Vers l'Egisle* (3,750 feet), the *Hôtel de Chamossaire* at Chésières (nearly 4,000 feet); *Le Sepey* (3,650 feet), *Château d'Oex*, *Gesseney* (Saanen), and several other smaller places have more or less the characters above mentioned. *La Comballaz* (4,480 feet) has less sun, and is more decidedly tonic, suitable in the middle of summer. *Gryon* (3,680 feet), near Bex, has fine air and some homely *pensions*, as has also *Les Plans* (3,650 feet), (different from Les Plans d'Ormonds).

Charming localities above *Montreux*, on the Lake of Geneva, are the *Hôtel des Avanse* (3,200 feet), and *Glion* (2,400 feet), both suitable for late spring, early summer, and late autumn; the former being open thoughout the whole year.

Near the western frontier of Switzerland, on the eastern spurs of the Jura, are three climatic health-resorts of medium elevation, dry, sunny, fairly stimulating; all three accessible by carriage road; *Chaumont* (3,845 feet) above the Lake of Neûchatel, with a remarkably fine view over the Lake and the Alps; *Weissenstein* (4,213 feet), in the Canton of Soleure, the highest and most bracing of the three, with a still more extensive view; *Magglingen*, or *Macolin* (2,900 feet), near *Bienne* or *Biel*, not on the height but on the slope of the mountain, about 1,500 feet above the Lake of Bienne, less stimulating, with many sheltered walks.

The large *Canton of Berne* possesses a great number of useful localities in elevations between 3,000 and 5,000 feet, but few of importance in the highest mountain regions, as the tourists' and mountain inns Faulhorn, Niesen, Männlichen, Wengernalp, Wengern Scheideck, and Schynige Platte, are scarcely suitable to invalids. *Engstlen Alp* (6,030 feet), with fair but limited accommodation, lies in a true Alpine valley, with beautiful flowery pastures, on the way from Meiringen to Engelberg, and is well suited to those who require tonic mountain air with perfect seclusion. *Mürren* (5,350 feet), above Lauterbrunnen, is one of the most refreshing summer resorts, rather cool for the elevation, being somewhat exposed to the east. It has a beautiful view on the Jungfrau and other giants of the Oberland, and the accommodation is of the best in this part of Switzerland. *Wengen* (4,100 feet), on the the way from Lauterbrunnen to Grindelwald, has some homely *pensions* in a healthy situation. *Beatenberg* (3,770 feet), above the Lake of Thun, accessible by carriage road, has a sunny aspect, level walks, and some woods, and is suitable from early summer to late autumn, especially to delicate invalids, with nervous irritability; such as require mountain air without being able to stand high elevation. The hotel on the *Abendberg* (3,740 feet), about two hours from Interlaken, belongs likewise to the milder summer resorts. The *Sulphur spa Lenk* (3,530 feet) lies on rising ground above the village An der Lenk, in the Upper Simmenthal, and forms a fairly sheltered summer resort. The *Gurnigelbad* (3,780 feet), about two-and-a-half hours from Thun, combines likewise sulphur springs with a very useful summer climate; it is situated on a hill, with abundance of fir plantations, and level as well as gently ascending walks. Another climatic spa, situated in a narrow well-wooded ravine near the Zweisimmenthal, is *Weissenburgbad* (2,940 feet), belonging to the same proprietors, and enjoying throughout the whole of Switzerland a great reputation in the cure of chronic bronchitis and the commencement of phthisis, due to the combined action of the sheltered pine-forest climate and the tepid lime waters. The *Rosenlauibad* (4,360 feet), near the well-known glacier of Rosenlaui, has a more tonic climate, but withal fairly equable, and sheltered by the pine forest. The walks are very tempting, more for healthy persons than invalids. The same may be said of *Grindelwald* (3,470 feet), principally visited on account of the beauty of its situation and the nearness of the two glaciers.

The neighbourhood of the *Lake of Lucerne* possesses a variety of mountain climates in addition to those on the shores, of which we will speak later. The *Rigi* alone offers a great variety from the base to the top. We will confine ourselves to those on the slopes and in the dells, which are all more or less stimulating, sunny, and rather windy. The *Rigi Kaltbad* (4,730 feet) is situated on a plateau rather sheltered from N. and E. winds, with south-western aspect, a favourite summer resort for all nations. The *Rigi First* (4,750 feet), not quite a mile from the Kaltbad, has an equally fine situation, with a splendid view over the lake. The *Rigi Staffel* (5,210 feet) has a fine view, but is too much exposed and too noisy for invalids. More quiet, but rather exposed, is the *Rigi Scheideck* (5,400 feet), with a southern aspect, close to a level plateau of a mile in length. The Scheideck is still more stimulating than either the *Kaltbad* or the *First*, and was thirty or forty years ago the principal resort of over-worked German professors and statesmen. The *Rigi Klösterli* (4,260 feet) lies in a basin, is less stimulating, and more homely in the accommodation which it offers.

Above the Axenstrasse we have another bracing locality with fair accommodation. The *Stoss Hotel* (4,406 feet), and lower down the well-known, very comfortable, but much less bracing *Hotel Axenstein* (about 2,500 feet), and the *Hotel Axenfels* (about 2,150 feet). On the ridge of the other side of this finest branch of the lake, called the Lake of Uri, lies on the slope of the Seelisberg Kulm, the village of *Seelisberg* (2,770 feet), with several good inns and *pensions*; and nearer Lucerne, *Schöneck* (about 2,250 feet) and the *Bürgenstock* (2,850 feet), with a well-placed and well-managed hotel, and shady walks. At some distance from the lake, in the Canton Unterwalden, *Engelberg* (3,315 feet), is one of the most favourite health-resorts of Switzerland, in a green valley, almost closed in by grand mountains, and thus fairly sheltered from winds. The valley is a mile broad and nearly six miles long. The place owes its origin and name to the famous Benedictine Monastery, *Mons Angelorum*, founded in the twelfth century. Another less known place in this neighbourhood, sheltered from cold winds, and well exposed to the sun, is *Nieder-Rickenbach* (3,830 feet). Both localities are much frequented by cases of chronic dyspepsia, chlorosis, and chronic bronchial catarrh.

On the St. Gotthard Road, *Andermatt* (4,740 feet), and *Hospenthal* (4,800 feet), may be mentioned; but more inviting by its beauty is the *Maderanerthal,* which branches off from Amstäg, watered by a very turbulent mountain stream, forming a constant succession of small cascades. At the head of the valley is the *Hotel Alpenclub* (4,790 feet), with a fine pine wood in its immediate neighbourhood, giving shelter from cold winds and shade from sun. As yet it can be reached only by a bridle path, and thus the crowd of tourists do not disturb the invalid.

In the neighbourhood of *Zug* are two health-resorts, principally of local reputation, but suitable also to unpretentious foreign guests: *Schönfels* (about 3,000 feet) and *Felsenegg* (3,000 feet), both on the slope of the *Zugerberg,* close to one another. Some miles to the east of Zug is the well-managed water-cure establishment, *Schönbrunn* (2,300 feet). The *Hotel Uetliberg* (2,860 feet), near Zurich, is well adapted for short stays, from early summer till autumn. The same may be said of the *Frohburg* (2,770 feet), near Olten; *Vorauen* (2,640 feet), and *Richisau* (2,590 feet), in the Canton of Glarus.

The Cantons of *Appenzell* and *St. Gallen*, which form the north-eastern corner of Switzerland, contain several localities which in former years possessed a great reputation as climatic summer resorts in phthisis, where the influence of the air was assisted by whey and milk. The elevation of these localities ranges only between 2,400 and 3,700 feet, but as they are mostly in very open situations, as there are no high mountains, nor large forests or lakes, the neighbourhood consisting almost entirely of green pastures, the climate is much more stimulating than that of similar elevations in the southern or south-western Cantons of Switzerland, or in the neighbourhood of the Engadine.* The principal localities are :—*Heiden* (2,645 feet), *Gais* (3,060 feet), *Appenzell* (2,550 feet), *Weissbad* (2,680 feet), *Heinrichsbad* (2,400 feet), *Teufen* (2,740 feet), *Wildhaus* (3,700 feet), the birth-place of the reformer Zwingli; all only suitable for summer.

The *Vorarlberg,* and the *Bavarian* and *Austrian Tyrol,* contain many useful mountain resorts which are little known in England. The *Schröcken* (about 4,200 feet), a homely village and pension in the Bregenzer Wald; *Mittelberg* (about 4,000 feet) in the Walser Thal; the *Achensee* (about 3,000), in the midst of pine forests; and the *Wildbad Kreuth* (2,700 feet), between the Achensee and the Tegernsee;

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* A more detailed description will be found in a paper by the author, "Notes on the Climate of the Swiss Alps, and some of their Health-Resorts and Spas." *Dublin Quart. Journ. of Med. Science,* Feb., 1864.

Wildbad Gastein (3,400 feet), more known by its warm baths than its climate; the *Fuscher*, or *St. Wolfgangsbad* (about 3,700 feet), in the Austrian Tyrol, with similar waters as Gastein; *Obladis* (4,400 feet), not far from Landeck.

The *Dolomites* are rather hot in the middle of summer, but possess good climatic resorts, fairly dry and stimulating, specially suitable for early and late summer. Winter resorts might probably be established under shelter, away from the high roads. The most accessible are *Cortina d'Ampezzo* (4,050 feet); *Schluderbach* (4,820 feet); and *Landro*, or *Höhlenstein* (4,750 feet); all these on the high road from Belluno, through the Ampezzo Valley, to Toblach in the Pusterthal. Away from the general track of tourists, in a beautiful situation at the Cimon della Palla, is the new *Hotel San Martino di Castrozza* (about 4,900 feet), looking into the Primiero Valley. To the west of the Dolomites, in the *Brenta*, *Adamello*, and *Presanella* districts, are delightful places, but none can as yet serve as a health-resort, excepting *Madonna di Campiglio* (rather over 5,000 feet), on the way from Pinzolo to Dimaro in the Val de Sole. In the valleys of the *Ortler district* the accommodation is scarcely inviting for a longer stay, but the *Rabbibad* (about 4,000), and *Pejo* (about 4,400), both with chalybeate springs, combine fine scenery and tonic qualities of climate and water, with tolerable accommodation. On the Italian side of the Alps, *Santa Catarina* (5,720 feet), near Bormio, possesses a tonic climate, with waters similar to those of St. Moritz. The new baths of *Bormio* (4,012 feet) are suitable to those who require dry heat, and understand how to avoid chills from sudden changes of wind.

The beautiful southern valleys of the Monte Rosa chain contain some charming, moderately tonic, and exhilarating localities, which are as yet scarcely enough appreciated by English health seekers. *Macugnaga* (5,115 feet), in the Val d'Anzasca, is perhaps not equalled by any other place in the Alps for the combination of grandeur and beauty. *Gressoney St. Jean* (4,500 feet) and *Gressoney-la-Trinité* (5,320 feet) are likewise in good situations; and *Alagna* (3,950 feet) is a favourite summer resort for Italians.

Courmageur (3,890 feet), to the south on Mont Blanc, at the head of the Valley of Aosta, is rather warm in summer, but the heat is dry, and the mornings and evenings are cool, so that it has a fairly tonic effect. *Pré St. Didier* (3,280 feet) is a little lower down in the same valley.

Hotel Monte Generoso (about 4,000 feet), in the Italian Lake district, combines elevation with a southern aspect, and is well adapted to those requiring sun-warmth with shelter from cold winds.

The preceding survey of mountain resorts in the Alps contains localities widely varying in character, in elevations between about 3,000 and 6,000 feet above sea. Some might have been separated from the rest and placed in the next group, but have been mentioned with their neighbours for the sake of convenience. We will now point out some localities of *lower elevation*, mostly between 1,000 and 2,600 feet, which comprise the resorts adjacent to the Lakes, and those in some lower valleys and slopes. The majority of these are of less importance to England, as the advantages they offer are scarcely sufficient to repay by themselves the long journey, excepting, perhaps, some places in the Swiss lake districts, which have peculiar charms in autumn, and also in spring. In comparing the climatic characters of these lower places with those of the higher regions, we may say, in general terms, that they are less stimulating; that their mean temperature is higher, showing less difference between day and night, and between sun and shade; that they are moister, and possess higher atmospheric pressure; the air is rather less pure; the admixture of organic matter is greater: it is, therefore, of special importance to avoid, in selecting a residence, sources of contamination, such as manure-heaps and manufactories. The neighbourhood of shady woods is necessary, as the heat of the sun in the moister air is very oppressive, and without shade it would be impossible to spend the greater part of the day in open air.

Oberstdorf (about 2,600 feet), near Sonthofen, in the Bavarian Alps; the *Faulenseeebad* (2,600 feet), near Thun; at and below 2,500 feet we mention in the order of their elevations: *Schliersee* in the Bavarian Alps; the pension of *Sonnenberg*, near Lucerne; the hotels at the *Giessbach*, above the lake of Brienz; *Langenbrück*, above the Hauensteiner Tunnel; the *Starnberger*, or *Wurm See*, the *Ammersee*, and the *Chiemsee*, in Bavaria; *Waidring*, in the Tyrol, between Wörgl and Reichenhall; *Zell on the Lake*, in the Tyrol; *Partenkirchen* and *Kainzenbad*, in the Bavarian Alps; *Aussee*, in the Styrian Alps; *Monnetier*, on the Salève, near Geneva; *St. Gervais-les-Bains*, and the higher and more airy *village* of *St. Gervais*, in Savoy; *Mürzzuschlag*, at the foot of the Semmering; *Obstalden*, above the Lake of Wallenstadt; the baths of *Stachelberg*, in Glarus; the *Kochelsee*, in the Bavarian Alps; *St. Radagund*, in Styria; the *Walchensee* and the baths of *Krankenheil*, near Toelz, in Bavaria; *Charnex*, above Montreux; the *Hotel du Signal de Chexbres*; the *Heustrich Bath*, near Thun; the chateau of *Ledenberg*, near Meran, in the Tyrol; *Innsbruch*, in the Tyrol; *Thun*, on the Lake of Thun; *Interlaken* and the *pensions* in the immediate neighbourhood; the neighbourhood of *Berne*; *Ragatz*, with its baths, in the Rhine valley; *Lausanne*, above the Lake of Geneva; *Mornex* on the Salève, and *Brides les Bains*, both in Savoy; the chalybeate spa of *Recoaro*, about 24 miles to the north of Vicenza, in northern Italy; *Allèvard les Bains*, in the Department of Isère; the villages and hamlets of *Peissy*, *Jussy*, *Chougny*, *Bourdigny*, *Cologny*, *Sacconex*, &c., in the neighbourhood of Geneva; the baths of *Salins*, in the Tarantaise; *Berchtesgaden*, *Königsee*, *Hintersee*, the *Ramsau*, and the baths of *Reichenhall*, in the Bavarian Alps; many of the charming places in the *Salzkammergut*: the baths of *Ischl*, *Salzburg*, and its neighbourhood; *Gmunden*, and *Ebensee*, on the Gmunden, or Traun-see; *Kammer* on the Kammersee; *Hallstatt* and *St. Wolfgang*, on the lakes of the same names; the villages on the *Lake of Lucerne*:—*Wäggis*, *Vitznau*, *Beckenried*, *Gersau*, and *Brunnen*; *Aigle*, and *Bex* with its salt baths, both somewhat above the Rhone valley; *Divonne*, a hydropathic establishment near the Lake of Geneva; various localities on the lakes of *Zurich*, *Constance*, and *Wallenstedt*; *Yverdun*, with its sulphur baths, *St. Aubin*, *Boudry*, *Columbier*, *Auvernier*, and *Neûchatel*, in the Canton of Neûchatel; *Beaurivage*, *Vevey*, and *Montreux*, on the Lake of Geneva, the latter being a complex of several localities: *Clarens*, *Vernex*, *Montreux*, *Territet*, and *Veytaux*. The more sheltered parts of Montreux offer some advantages as winter quarters to invalids who do not require perfect protection from wind, and can bear occasional sudden changes of temperature.

The autumn is the best time, when the grape cure may in suitable cases be combined with the influence of climate. The dusty roads form, however, a great drawback.

Meran, in the Austrian Tyrol, which forms, together with *Obermais*, a single health-resort, has enjoyed, and still enjoys, a certain reputation in the climatic treatment of consumption. The elevation of different villas varies from 900 to about 1,100 feet; it is entirely sheltered by very high mountains from N.W., N., and N.E., excepting where the mountain torrent (Passer) forces its way through them. It is sunny, and the soil dries rapidly, so that the neighbourhood of the high road is dusty, in spite of a considerable amount of rain. The relative moisture from October to April varies from 65° to 80°. The average winter temperature is about 42° Fahr., but the sun temperature is very considerable. The reputation seems to be due not so much to the climate as to the careful management of the physicians (Drs. Tappeiner, Pircher, Knauthe, and Von Messing), by which the invalids are enabled to spend a great part of the day in the clear, dry, cold winter air, and the feeding and habits are judiciously regulated. The village of *Gries*, near *Botzen*, about nine miles from Meran, has a similar position, and an analogous climatic character.

The *mountain resorts of Germany*, apart from those belonging to the Alps and mentioned with them, are of very moderate elevation, from about 1,000 to 3,000 feet, and are only used as summer climates, with the exception of the special establishments for the treatment of phthisis: *Görbersdorf* in Silesia, and *Falkenstein*, near Soden, to which, from a communication by Dr. Haufe, *St. Blasien* in Baden may be added. *Görbersdorf*, about 1,750 feet above sea-level, in a valley of the Silesian district of Waldenburg, is the place where Dr. Brehmer, about twenty-five years ago, commenced the treatment of phthisis. In summer the winding character of the valley, and the surrounding hills covered with pine-wood, cause absence of wind and a certain amount of equability in temperature and moisture; and the purity of the air from dust, the gently ascending walks up a pine-clothed hill, nearly 1,000 feet above the establishment, are very valuable points; the winter, however, is rough and changeable.

Falkenstein (about 1,500 feet), on the Taunus, may be called an imitation of Görbersdorf. The house is in a tolerably well-sheltered position, and some high walls offer additional shelter to those sitting and walking in the open air. Those who know the climate of the centre of Germany at the elevation of Falkenstein must know that it leaves much to be desired; yet, under the intelligent guidance of Dr. Dettweiler, late second physician at Görbersdorf, truly satisfactory results are obtained. It is very interesting, and also very important, to inquire how these results are worked out at these two establishments. The answer ought to be—certainly not by climate alone, but by method, which consists principally in the judicious arrangement of the manner of living, of the nature and number of meals, including wine, the amount and quality of exercise, the living in the air as far as possible, the assistance in many cases of hydrotherapeutic means. Thus we may indeed say that by careful guidance, which is almost only possible in a medical establishment, better results are obtained in indifferent climates than without strict guidance in much better climates.

St. Blasien (2,500 feet), which is to be opened also as a winter resort, lies in one of the southern valleys of the Black Forest, surrounded by pine-covered hills, protected from N.W., N., and N.E., open only to S.W., S., and S.E. The immediate neighbourhood of extensive pine forests supplies further shelter. Dr. Haufe resides summer and winter at St. Blasien. The nearest station is Albdruck, but it may also be reached from Freiburg and Waldshut.

We now pass on to the other German summer resorts, and begin with those between about 1,500 and 3,000 feet above sea-level. *Höchenschwand*, in the southern part of the Black Forest, is the only place with good accommodation which exceeds 3,000 feet in elevation. The majority of the following lie in well-wooded districts. *Waldau, Schluchsee, St. Märgen, Bonndorf, Todtmoos, Steinamühle, Triberg, Rippoldsau, Griesbach, Antogast,* all in the *Black Forest,* the last three being well-known chalybeate spas. *Hohwald, Dreiaehren,* and *Odilienberg,* in the Vosges Mountains; *Karlsbrunn,* in Austrian Silesia; *Wildenthal, Königswart* (chalybeate spa), in Bohemia, *Reiboldsgrün, Frauenstein, Gräfenberg* (the well-known hydrotherapeutic establishment); *Schreiberhau, Reinerz* (chalybeate spa); *Flinsberg* (chalybeate spa), *Schwarzbach,* in Silesia; *Heiligenberg,* on a spur of the Rauhe Alb, near the Lake of Constance; *Johannesbad,* a Wildbad in Bohemia; *Hohegeiss, Clausthal, Andreasberg,* and *Altenau,* in the Harz Mountains; *Muggendorf* and *Streitberg,* in Frankish Switzerland; *Brotterode,* in the Thuringian Forest, as also *Ilmenan* and *Elgersburg,* two hydrotherapeutic and climatic establishments; *Alexanderbad* (hydrotherapeutic and chalybeate spa) in the Fichtelgebirge.

In elevations varying from 900 to 1,500 feet are still useful summer resorts.

In the Erzgebirge: *Olbernau, Wolkenstein, Warmbad, Einsiedel, Wiesenbad*—all more or less forest or wood climates.

In the central part of the Black Forest: *Schönmüntzbach, Petersthal* (saline chalybeate spa), *Teinach* (hydrotherapeutic spa), *Feiersbach, Herrenalb* (hydrotherapeutic establishment), and *Liebenzell.*

Badenweiler has a very fine position on the western slope of the Black Forest; it possesses tepid springs, used already by the Romans, and has good arrangements for milk and whey cures.

In the Thuringian Forest: *Friedrichsroda, Ruhla, Tambach, Georgenthal, Ohrdruff, Louisenthal, Schleusingen, Sonneberg, Blankenhain, Liebenstein* (chalybeate and hydrotherapeutic spa), and *Arnstadt* (brine baths).

In the Riesengebirge and Erzgebirge: *Schmiedeberg, Buchwald, Roznau, Liebwerda, Petersdorf, Erdmannsdorf, Hermsdorf, Warmbrunn, Fischbach, Eichwald,* and *Hartenstein.*

In the Harz Mountains: *Grund, Alexisbad, Sachsa, Blankenburg, Stolberg, Thale, Wernigerode, Ilsenburg,* and *Harzburg.*

All these localities can scarcely be called mountain climates, but are rather *hill climates,* and mostly, at the same time, *wood climates,* to which we will only add a few others as representatives of their neighbourhoods: *Königsberg,* on the *Taunus;* the *Laacher See,* a beautiful solitude in the volcanic region of the *Eifel; Jugenheim, Weinheim, Dürkheim, Neustadt,* and *Gleisweiler,* in the *Odenwald* and *Haardt.*

The Apennines and the Maritime Alps contain many localities which would be suitable as summer resorts, but the arrangements for the reception of invalids are mostly so defective that there are only few places in these vast regions which are as yet available. The most promising are *Abetone* and *Serrabassa* (about 5,000 feet) in the Apennines, which Dr. Young, of Florence, has described. The nearest railway station is Pracchia, between Bologna and Florence.

In the Maritime Alps, *St. Martin Lantosque*, about forty miles north of Nice, offers fair accommodation, at an elevation of about 3,150 feet, from June to September; and, in a smaller way, *Berthemont*, *Belvedère*, *Bollène*, and *La Cascade*. On the Italian side of the Maritime Alps we mention the *Certosa di Val Pesio*, in a beautiful position, with hydrotherapeutic arrangements, near Cuneo; the baths of *Valdieri* and *San Dalmazzo di Tenda*, near the foot of the Col di Tenda.

In the Apennines of old Etruria, *Perugia* and *Siena* are the only places which offer to invalids thoroughly comfortable accommodation.

France is not rich in health resorts of great elevation, but it possesses a fair number of good localities, between 1,500 and 3,500 feet. We have already mentioned several places in the Maritime Alps. The Alps of the Dauphiné contain, likewise, some towns and villages above 3,000 feet; as, for instance, the fortress of *Briançon* (Hautes Alpes), 4,300 feet, but there is no suitable accommodation for invalids. Refreshing summer climates, however, are to be found at the baths of *Allèvard* and of *Uriage*, both not far from the railway, between Chambéry and Grenoble. On the western slopes of the Vosges Mountains, too, France possesses some good summer climates; perhaps rather warm, but suitable for delicate constitutions; such as *Rémiremont*, *Plombières*, *Gérardmer*. In the Auvergne: *Mont Dore*, *La Bourboule*, and *Royat*, are not only very useful spas, but also good climatic resorts, with excellent hotels; while other less-known localities, as *Châtelguyon*, *Châteauneuf*, and *St. Nectaire*, are, as yet, scarcely suitable for English invalids. In the Pyrenees many localities combine agreeable and gently stimulant climates, with mineral springs, mostly sulphurous, and good accommodation: *Barèges*, *Cauterets*, *Bagnères de Luchon*, *Bagnères de Bigorre*, *Eaux Bonnes*, *Eaux Chaudes*, *Argelèz*, *Pierrefitte*, *St. Sauveur*, and *Luz.* In the western Pyrenees: *Amélie-les-Bains* (the former *Arles-les-Bains*) and *Vernet-les-Bains* are also *winter* stations; the former of which especially enjoys a well-deserved reputation in cases of chronic laryngeal and bronchial catarrh. *Palalda*, on the road from Perpignan to Amélie, might likewise be used as a winter station.

On the Spanish side of the Pyrenees, *Penticosa*, or *Panticosa*, at an elevation of 5,700 feet above sea-level, with weak sulphur waters, is considered very efficacious in the treatment of consumption; but it is used only during summer, while probably the winter possesses even greater climatic advantages. Another fairly tonic mountain climate of the Spanish Pyrenees is *Les Escaldas*, about 4,700 feet, not very far from the above-mentioned Vernet-les-Bains.

The mountains of England and Scotland have rather different climates from those on the continent of Europe; the insular position produces a greater degree of moisture, as well of soil as of air, greater equability of temperature, more rain, and more mist. The summer climate of the moors of Scotland and Yorkshire is thoroughly invigorating, and cannot be compared with the drier continental health resorts of equal elevation. Unfortunately, many of the best neighbourhoods are inaccessible to invalids, as there are no hotels or sanitaria; possibly the landed proprietors do not like the disturbance of the game by visitors or invalids strolling about on their moors. We possess, however, a considerable choice of tolerably bracing, though not very elevated, localities. In Scotland: *Braemar* and *Ballater*, *Pitlochrie*, *Blair Athole*, *Inversnaid*, the *Trosachs*, *Crieff*, *Moffat*, and *Strathpeffer*, the two last having the advantage of sulphurous springs; and the *Bridge of Allan*, a muriated saline spa, with a much milder climate than the other localities mentioned, and fair shelter from cold winds in spring. In England, the well-known spas of *Buxton* and *Harrogate* may be said to have stimulating climates, and the *moors* in the neighbourhood of Buxton still more so; the influence of the air, for instance, at the little inn called "The Cat and Fiddle," is much more bracing than that of Buxton, in the valley beneath. *Ilkley*, with the hydrotherapeutic establishments in its neighbourhood, is likewise thoroughly invigorating, as also *Gilsland*, in Cumberland. *Great Malvern* is milder, and has a fine position. *Llanberris*, *Llandrindod*, *Builth*, and many other places in Wales, may be recommended for climate as well as waters. The sand and chalk ridges of the south of England have invaluable advantages for the metropolis; as, for instance, the ridges of *Leith Hill*, *Tunbridge Wells*, *Frant*, *Sevenoaks*, *St. George's Hill* near Weybridge, *Hayward's Heath*, and the *Dartmoor*. *Clifton*, in the west, combines moderate elevation with nearness to the sea, and has been justly appreciated by Sir James Clark. Some of these localities, however, have scarcely a claim to be regarded as hill climates.

America possesses, in its *Rocky Mountains* and *Cordilleras*, an endless variety of mountain climates, which have already attracted attention, but will sooner or later be much more largely resorted to. Near the equator, elevations of 6,000 to 8,000 feet have temperatures, even in winter, quite as high as our temperate regions in summer; and only still higher localities can be recommended in the treatment of consumption and consumptive tendencies, but at greater distances from the equator conditions resemble somewhat more those of the Alps and Pyrenees. In the Peruvian Andes we have most experience of the *Valley* of the *Jauja river*, at an elevation of from 8,000 to 10,500 feet, partly from the description of Archibald Smith,* partly from the prolonged observations of several patients. The two principal health resorts for consumptive invalids from Lima are the towns of *Jauja* and *Huancayo*. "At Huancayo, 12°0′ S. lat., and 75°12′ W. long., the annual range of temperature in the shade may be taken as ranging from 8° or 9° to 14° Reaum.; while at the cooler town of Jauja, with from 10,000 to 15,000 inhabitants, the range during one whole year has been observed not to exceed from 8° to 12° Reaum., or from 50° to 59° or 60° Fahr., with a sky always clear and sunny, and an atmosphere pure and bracing, which invites to outdoor exercise and enjoyment." In no other climate have we witnessed such good results on our patients as in the Peruvian Andes; but the distance from home is great, and some invalids find it difficult to accustom themselves to Spanish, or rather Peruvian-Spanish, habits of life.

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* "Climate of the Swiss Alps and the Peruvian Andes Compared." By Archibald Smith, M.D. *Dublin Quarterly Journal of Medical Science*, May, 1866.

Consumptive invalids have also spent one or several years in other parts of the Andes or Cordilleras with great advantage, especially at *Santa Fe de Bogota* (about 10,000 feet), in New Granada; *Quito* (about 10,000 feet); *La Paz* (12,200 feet); and *Cuzco* 11,250 feet. *Mexico*, too, possesses good health-resorts, particularly the *capital* of Mexico and *Puebla*, about which the well-known works of Jourdanet and Guilbert contain valuable information. Mr. Scrivener has spoken to us very highly of the mountains of the *Argentine Republic*, and from the towns of Brazil consumptive patients are frequently sent up to the Cordilleras.

In the United States, the Rocky Mountains have, during the last fifteen years, been used as health-resorts in consumption, especially *Manitou Springs* (6,315 feet); *Colorado Springs* (5,775 feet); and *Denver* (about 5,000 feet). These regions have to English invalids the great advantages of language and affinity of thought and habits, and the possibility of finding occupation and of permanently settling—advantages which outbalance the distance from home. A more detailed description will be found in the works of Drs. Solly and Denison. *Manitou Springs* is the place which is most adapted to real invalids. It is 38°5′ N. lat., and 105°5′ W. long. The mean temperature for winter is about 27° Fahr.; for spring, 45°; summer, 68°; autumn, 48°. The number of clear days is great; and the relative dryness of the air is remarkable; the average is usually given between 45° and 50°; there are only about sixty-six to seventy rainy days, and amongst them about forty with snow, which, however, does not remain so long on the ground as at Davos, and the melting of the snow does not seem to have the same disagreeable effects as in the Swiss Alps. Wind is by no means absent, but Manitou is to some degree sheltered. The temperature varies considerably in the different seasons, the sun and shade, by day and night. We have, therefore, a somewhat changeable climate, with great dryness of atmosphere and soil, and many clear days. Autumn and the first part of the winter are the best times; spring is changeable and windy; summer rather hot; so that the majority of invalids go up to higher localities, and camp out in tents.

It is very probable that in the course of time some better climates for phthisis may be found in the United States than Colorado and Manitou, though the results are fairly satisfactory. If we consider the elevation of entire states in North America and the character of the vegetation, the confidence which we express in the future appears not quite unfounded. We will quote the altitudes of some states from Toner's "Dictionary of Elevations":—Wyoming, 7,200 feet; Colorado, 6,500; Arizona, 6,000; Idaho, 5,800; Utah, 5,500; Nevada, 5,400; New Mexico, 5,300; Montana, 4,500; California, 2,500.

The State of *Minnesota*, U.S.A., the mean elevation of which is 1,100 feet, has been often mentioned as favourable to the cure and prevention of phthisis. The state is as yet very scantily populated, and it is probable that part of the reputation depends on this scantiness of population, and the open-air life led by the settlers.

The *South African altitude regions* deserve, likewise, a greater share of attention than we are able to give them. Dr. Symes Thompson and the late Dr. Harry Leach have, amongst others, directed attention to these climates; to these authors we must refer for information, and also to interesting works by non-professional authors, as Mr. Trollope's work on South Africa, Mr. E. F. Sandeman's "Eight Months in an Ox-wagon," and Mr. Otter's "Winters Abroad." The *Orange Free States*, *Griqualand West*, and the *Transvaal*, contain the most important health localities, and *Bloemfontein* has for a long time enjoyed the greatest reputation. Many years ago inhabitants of the Free States have assured us that in not too advanced cases of phthisis the cure was "absolutely certain." Experience has not quite confirmed this sanguine statement. The elevation of Bloemfontein is about 4,700 feet. H. Leach, an impartial writer, says of it, "There are many places, as to climate, quite as good as Bloemfontein, both in the Orange Free State and elsewhere. But the latter is a good geographical as well as climatic centre, and the kind and hospitable attention accorded to visitors gives an especial charm to the quiet capital of this little republic." Many of the places of which H. Leach had a high opinion are in the Transvaal: Christiana, Bloemshoff, Potchefstroom, Witwater Rand, Pretoria, Heidelberg, Utrecht, Standerton, and Wakkerstroom (over 6,000 feet). Everywhere the climate is very dry, the summers are very hot, and the winters often very cold.

Whoever thinks of trying the *South African highlands* must bear in mind that a long sea voyage and a long land journey are included in his plan. Those who bear sea voyages well need not regret the former, and the latter can likewise be rendered beneficial, if the invalid is not too weak, and does not mind a certain expense. The best mode to reach the high regions from the coast is to proceed in an ox-wagon, well supplied with the necessaries of life, including books, either from Wynberg, or from Grahamstown. "Wagon travelling, with the traveller's own oxen," Mr. Otter justly says, "is very slow work, not averaging more than from ten to twelve miles a day;" but as such an expedition "is only made for the sake of health, the rate of travelling is not material; and when once a traveller has got into a district which is suitable to him, he is in no hurry to get out of it." Mr. Otter concludes his chapter with another remark, which we know from observation to be judicious—viz., that invalids should not remain long at or near Cape Town, and should not take up their abode for any length of time within 100 miles of the sea-coast, nor less than 1,500 feet above sea-level.

Many of the great mountain chains of *Asia* contain, no doubt, useful health-resorts; but our dependable knowledge is confined almost entirely to the hill stations of India, where, above all, the *Himalaya chain* encloses the greatest variety of climates, its length being at least 2,000 miles, and its average breadth 180 miles, its elevations ranging from 1,000 feet to over 23,000 feet. The south face alone may be said to possess all kinds of climates, from the tropics to the poles; and while the eastern portion of this face is excessively humid, the western is rather dry. There are besides the *Neilgherry* range, the *Pulneys*, the *Aravulli* or *Aravelli Mountains*, the *Vindhya* range, the *western* and *eastern Ghauts*, and several other ranges. The Indian annals of medicine contain many valuable reports, to which we must refer for information, and restrict ourselves to naming the principal stations and their elevations from a table in Dr. Parkes's "Hygiene":—In the Bengal Presidency, between 6,000 and 8,300 feet high: Darjeeling, Simla, Landour, Murree, Kussowlie, Nynie Tal, Dugshai, with mean annual rainfall between 70 and 132 inches. In the

Neilgherry range (Madras) between 5,160 and 7,600, Ootacamund, Kotagherry, Wellington, Coonoor, with a rainfall between 50 and 60 inches, Pulneys (7,000 feet) and Annamullays (6,800 feet). Likewise in the Madras Presidency, Shevaroys (5,260 feet), with only 40 inches of rain. In the Bombay Presidency: Mahableshwur Poorandhur, and Mount Aboo (between 4,000 and 5,000 feet), the first with 240 inches, the two others with between 70 and 80 inches, of rain.

In considering the hill stations of India, it is necessary to bear in mind the nearness to the equator, by which the influence of altitude is considerably modified; and, further, the fact that the peninsula is surrounded, with the exception of its broad base, by large masses of warm water. The periodical winds coming from these seas are saturated with vapour, which, on reaching the cooler mountain ranges, is partly deposited as rain. From the damp soil, moisture, mixed with organic matters, rises into the atmosphere, which thus becomes more humid and less pure. The majority of hill stations in India have, therefore, very different climatic conditions from those of the Andes, the Rocky Mountains, or the Alps. Nevertheless, these hill stations, though they could scarcely be recommended to inhabitants of Europe, are of the greatest climatic value to the population of India and the Europeans living there. The circumstances just mentioned may explain the contradictory views of Anglo-Indian medical men regarding the influence of their hill stations on phthisis. Dr. Kellett's carefully drawn up report, however, on consumptive soldiers, who spent six months—April to November—at the convalescent station of *Landour*, shows results which are by no means unsatisfactory.

Very different are the climates north of the highest ridges of the Himalayas, for the atmosphere before reaching them has lost the greater part of its moisture on the southern slopes and the highest ridges of the chain, so that the same winds which brought to the latter such enormous masses of rain and snow are in the north comparatively dry winds. Hence, *Cashmere*, about 5,000 to 6,000 feet high, and *Tibet*, 9,000 to 11,000 feet high, have totally different conditions from those prevailing at similar elevations to the south, and it is very probable that most useful health stations could be founded in these drier and cooler climates.

II. Lowland or Plain Climates.

After having placed so many regions under the heads of marine climates, and under those of altitude or mountain climates, we need only take a cursory glance at the large field of lowland climates, the most important classes for therapeutic purposes being included in the former divisions. Without attempting any further classification we will at once proceed to *Egypt*—a region which is to the student of climate and its effects as interesting as to the student of man, his art and progress. We meet at once with two mighty physical influences: the *Desert* and the *Nile*. The prominent climatic features of the atmosphere are due to the former, the possibility of existence in affluence and its early fruits—art and cultivation, with their wide-spreading influence—are due to the latter.

We have first to deal with the *Desert*, the characteristics of which are:—great dryness, transparency, and transcalency of air; powerful influence of the sun, shining upon it almost constantly from rising to setting; excessive radiation into the clear sky from sunset to sunrise; cool, sometimes very cold, nights, with heavy dew; rarity of rain. The heat by day, though great, is not oppressive; it allows much exercise without lassitude, and without excessive perspiration. This real desert climate, stimulating and exhilarating, has, as yet, not been systematically employed in the treatment of disease; but it would be possible to use it in properly-arranged establishments with great advantage. We had the opportunity of watching its effects on invalids in several instances, especially in two advanced cases of phthisis (living in tents), where existence and the greatest possible degree of relative health were maintained during several entire years, till circumstances compelled or induced the invalids to return to their homes and then to other places, where the disease again resumed its usual course. The climate of the real desert, away from congregations of man, is as *aseptic* as that of the glacier, and the preceding sketch shows other points of analogy, in spite of the great difference in temperature and atmospheric pressure.

The nearest approach to the desert climate is in *Nubia;* and, again, from repeated prolonged stays in Nubia we have seen the greatest benefit in cases of phthisis and chronic rheumatism, chronic catarrhal conditions, and scrofulous complaints; but again the isolation of tent life was found too unsympathetic to the more gregarious members of the parties. Next to Nubia we must place those localities which lie on the borders of the desert, and share to *some degree* its climatic elements: *Ismailia* or *Ismailiya*, which has been claimed from the desert, is quite a new town, and offers some accommodation; but it is partly under the influence of the sea, and can, therefore, not be altogether considered as a desert home. It is, however, a fairly good winter resort, better than Cairo for invalids, at least those with chest troubles.

A purer desert climate, though like the preceding, not altogether, is *Heluan*, about fourteen or fifteen miles south of Cairo, three miles from the Nile, consisting of a few villas and a hotel and bath-house. It lies about 112 feet above the level of the Nile, on a firm plateau of sandy soil. Compared with Cairo the air is dustless and pure. The mineral springs belong to the hot saline sulphur class, and assist the climate in the treatment of chronic rheumatism and gout. We have, indeed, nothing equally good in Europe, particularly in winter.

Cairo is a large town, with all its social and hygienic drawbacks to the more serious invalid. The high mortality shows how necessary it is to be cautious. At Cairo the air is often sultry, the differences between shade and sun and day and night are great, there is a peculiar chilliness at about sunset which requires care, and the sandy dust is frequently irritating. With all this, however, the climate of Cairo partakes to some degree of the above-mentioned good qualities imparted by the desert to its neighbourhood. All the numerous authors—English, French, and German—agree that the sky is nearly always clear, that a drizzle is almost unheard of, that rain is very rare, and that one can count with a great degree of certainty on continuous fine weather, while, with regard to our own invigorating English and all other European climates, even the Rivieras, we are always obliged to say that nothing is certain but the uncertainty.

The *Nile voyage* generally forms part of a winter in Egypt, and is considered by many visitors as the most useful part of the climatic cure; but it is by no means without its risks, and must not be undertaken at all by very delicate and weak invalids, or, at all events, only in company with a physician, and by all invalids with due precautions, for the nights are often very cold. The best time to begin the Nile journey is towards the end of December, when the banks of the Nile have had time to dry from the annual overflow, and when the north wind, though sometimes too cold and too strong, assists the passage of the boat. A stay of some weeks at the *Luxor* Hotel, near Thebes, is for most invalids preferable to a prolonged stay at Cairo. A second stay at *Assuan* may be extended, according to the condition of the invalid, over some weeks, in order to be as long as possible in the pure air of Upper Egypt; but it is desirable to be back in Cairo about the middle of March, and to leave Egypt at the end of the month.

The invalid's stay in Egypt usually begins with November and ends with March, and only in exceptional cases can an earlier arrival or a longer stay be permitted. In April the heat is generally excessive, and, in addition, the *Chamsin*, hot and charged with the finest particles of sand, may blow as early as this month.

The morbid conditions in which the climate of Egypt—especially Upper Egypt, the Desert, and Nubia—is beneficial, are the early stages of non-erethic forms of phthisis, or quiescent phthisis, even in advanced stages; chronic bronchitis; catarrhal conditions of the air passages, and emphysema, with much secretion, principally in advanced age; chronic rheumatism and gout; albuminuria; climacteric and many other conditions which we have mentioned when speaking of the Western Riviera.

Amongst the drawbacks of the climatic cure in Egypt are the distance from home, the fatiguing journey and voyage for those who are not good sailors, and the difficulty of finding intermediate places after leaving Egypt at the end of March. The last is the most serious drawback, for to return to England at that time is out of the question; Switzerland, too, is not yet satisfactory; Palermo, in Sicily, gives perhaps the best chance, but the wind is sometimes high and cold, even at Palermo, in April. Dr. Marcet recommends moderately high places in a warm country, such as the Villa Orotava, 1,200 feet, or Laguna, about 2,000 feet above the sea, in the Island of Teneriffe: "assuming, of course, that the patient is well enough to go about and live, within certain limits, in the same way as a healthy person."

Great advantages as a winter resort, especially to rheumatic and gouty invalids, are offered at the Algerian spa and climatic resort, *Hammam R'Hira*, to which Mr. Pollock and Dr. Lauder Brunton have directed attention. The winter climate is moderately warm, dry, and stimulating, as we should expect from its position amongst the hills of a projecting range of the lesser Atlas. It lies 60 miles S.W. of Algiers, 15 miles in direct line from the coast, and a few miles from the Bon-Medfa station on the Oran Railway. The new hotel is beautifully situated on a slope, with pine woods in its neighbourhood. October, November, and part of December are beautiful; in the second part of December and in January it frequently rains; and February and March are still showery; April and May fine. The well-arranged baths are supplied by hot saline springs, which were extensively used by the Romans; a cold chalybeate spring for drinking is a further recommendation to Hammam R'Hira; and the presence of an English-speaking physician is likewise a great advantage.

The climate of *Pau*, in the valley of the Gave, the capital of the Department of the Basses Pyrénées, about 630 feet above sea-level, has been carefully described by Sir A. Taylor* and many others. It is in its greater circumference surrounded by hills, and through this enjoys a considerable calmness of atmosphere, with the exception of occasional storms. The mean temperature during the invalid's season, from November to April, is about 48°·6 Fahr., which is nearly 5° less than at sheltered parts of the Rivieras; the air is less dry; the rainfall and the number of rainy days are greater than at the Rivieras; but the temperature is rather more equable, though there are occasional periods of cold; there is less sunshine and sun-heat. The climate has a *sedative character*, and generally suits persons with an irritable nervous system, with tendency to febrile excitement, combined with emphysema, chronic bronchitis, and irritability of the larynx. It is not suitable in cases of relaxation of the mucous membrane and atony of the nervous system; and even in healthy persons it frequently produces such a condition. March, April, and May are, as a rule, less irritating at Pau than at many other health resorts of Europe, though the weather is by no means settled.

Dax, on the line from Bordeaux to Bayonne, at the S.E. corner of the Landes, somewhat partakes of the climatic characters of Pau, but is rather less sheltered from wind, and rather more under the influence of the Atlantic. The hot springs and well-arranged baths are useful in rheumatic and catarrhal complaints.

Arcachon in this region has been described amongst the sea-shore climates, though its climate is intermediate between land and sea climates.

In the interior of Italy there are many delightful localities which may be occasionally used by invalids, but few can be regarded in the light of climatic health resorts. The Italian lakes, however, have some suitable places for prolonged residence. *Pallanza* on the Lago Maggiore, *Lugano* on the Lake of Lugano, and the *Villa d'Este* on the Lake of Como, are used as spring, autumn, and winter resorts. The climate of each of these places is somewhat different, but they have in common the position to the south of the Alps, a fair degree of shelter from cold winds, through mountains and the influence of the lakes on the shores of which they lie. They are less warm and less sheltered than the Rivieras, they have a smaller number of clear days and much more rain; but compared to the climates of England, the number of clear days and the amount of blue sky and sun are decidedly greater. The relative humidity is lower than in England—the mean for the year at Pallanza, according to Dr. Scharrenbroich's carefully-written work, being only 67°·6; the number of bright days, 185; that of rainy days, 61. *Pallanza* is the warmest of the places on the Lago Maggiore, open in winter, yet the mean temperature of December, January, and February, is only about 39°·1 Fahr., similar to the inland places in the south of England, while that of the spring months is 54°·4, summer 71°·4, autumn 55°·65. The climate may be regarded as rather dry and stimulating. *Lugano*, of which Dr. Thomas, of Badenweiler, has given a good description in his contributions to Climatology, is in winter nearly 2°, and in spring 1°·5 Fahr., cooler than Pallanza. These three lake places are comparatively good transition climates in spring and autumn from warmer to cooler, and from cooler to warmer localities;

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* "The Preventive and Curative Influence of the Climate of Pau." 1856.

and they may also be resorted to by fugitives from the snow-melting period in Davos and St. Moritz. Other localities on the lakes used as spring, summer, and autumn climates, are :—*Stresa*, *Baveno*, *Locarno*, on the Lago Maggiore ; *Orta*, on the beautiful little Lago d'Orta; *Menaggio and Bellagio*, on the Lake of Como; and *Varese*, a favourite summer resort of the Milanese. The *Lago di Garda* offers only at *Riva*, which belongs to the Austrian Tyrol, decent accommodation for summer. All these localities are rather hot in summer, and suitable only to those who like great heat, and a certain degree of *dolce far niente.* The cooling effect of bathing in the lakes is, however, to be taken into account. About a mile from Riva, inland, lies the little town of *Arco*, which is used as a winter resort. It is somewhat warmer, as testified by the vegetation, than the winter places at the Italian lakes, and is said to enjoy great calmness of air in winter, but the sheltered walks are limited.

The baths of *Lucca*, about 15 miles from the town of Lucca, have a rather warm, but, to the lovers of heat, delightful summer climate with good accommodation, and many shady walks.

It would be a great pleasure to dwell on the towns of Upper and Central Italy, but they cannot be regarded as health-resorts, as their climates are very changeable. It is impossible for those who feel themselves fairly well to avoid *Florence*, where April, May, and the second part of September and October are the best months; but the changes are sudden and great, the winds from the Apennines often icy, and the sun in unsheltered places hot, so that great care is required with regard to clothing and exposure by every one who is not quite strong. The character of the climate is decidedly stimulating.

Perugia and *Siena* have been already mentioned as fair hill climates.

Rome enjoyed in former years a great reputation in the treatment of phthisis, but the daily range of temperature in the Eternal City is often great, and the winds sometimes very cold. November is often rainy; December, January, and February are mostly cold; March, April, and part of May are, however, as a rule, very pleasant, and suitable to pulmonary invalids without fever, and to those affected with bronchial catarrh, rheumatism, and gout, if they exercise due care in avoiding the fatigue of sight-seeing, and the changes of temperature from a hot sun to cold galleries or churches. There is a large class of persons who are not invalids in the usual sense of the word, but are not in health as to mind or body, or both, such as persons affected with mental depression from various causes, or suffering from overwork, want of satisfaction in their work, or imperfect recovery from physical diseases or mental shocks, or difficulty in bridging over certain periods or stages of life. To such persons a whole winter at Rome, spent in studying art or antiquities, or visiting the most interesting neighbourhoods without fatigue and exposure, is often of the greatest service, and forms sometimes a turning-point to a happier and more successful life. The climate of Rome is not so stimulating as that of Upper Egypt or the Desert, or even Cannes, or Nice, or Florence; but it is not relaxing. It maintains an intermediate place between Pau and the Rivieras.* During May a fortnight or a month on the *Albanian Hills*, near Cicero's Tusculum, forms a most agreeable and healthful change.

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* What is usually called "Roman fever" is not a specific complaint, but sometimes typhoid fever receives that name, sometimes malaria fever. The latter can be, with due care, entirely avoided; indeed, it is rare during winter in Rome itself.

There are many other localities, which may be used as climatic health-resorts, too numerous to be named even in a much larger treatise than this. England, Scotland, and Ireland are very rich in this respect; but every country of Europe abounds in them. Some are suitable only to certain limited classes of cases, and at limited periods of the year; many are defective in accommodation; but almost every large town in Great Britain and on the Continent possesses, at no great distance, localities which, with careful consideration of all circumstances, and strict guidance as to management, can be rendered highly useful in the treatment and prevention of many morbid conditions. A few remarks on this subject will be contained in the following sketch.

Hints on the Selection of Climates and Climatic Health-Resorts.

We feel that we are now treading on difficult ground, for in advising climatic resorts for the treatment of various ailments, it is impossible, even in a purely professional article, to lay down fixed rules. As in every kind of medical treatment, so it is in climatic treatment; it is not the *disease of a certain name*—say consumption or gout—for which we prescribe, but the *individual case*—viz., the person in whom the disease exists, including the whole of his or her physical and mental constitution, with due appreciation of the circumstances surrounding the case. Our remarks can, therefore, be of a general nature only, as will be clear by discussing two or three apparently simple questions.

What is a *good climate?* Where all the organs and tissues of the body are constantly kept at work, alternating with rest. Health is the effect of constant change of all the tissues of the body; change is the essence of that harmony which is health. This harmony is procured by the constant change in the external agencies supplied to the body through atmosphere and food. A climate which consists in constant moderate variations in its different factors—especially temperature, moisture, light, electricity, wind, and atmospheric pressure—is the best climate for the maintenance and promotion of health in fairly vigorous persons. It calls forth the energy of the different organs and functions, their power of adaptation and resistance, and thus keeps them in working condition. Much less good climates are those in which the same conditions prevail for long periods of the year—the same degree of bright sunshine, of moderate wind, dryness, and warmth. In such climates the powers of adaptation and resistance are not called forth, and are apt to lose their energy. Agreeable climates are not always good climates, and disagreeable climates often are the best. The climates of England all the year round are probably the most health-giving in the world. The climates of Italy, of Spain, or Madeira, are infinitely inferior. But a climate good for the *healthy* is often bad for the *weak* or *diseased*, whose organs have lost, permanently or temporarily, their power of resistance or adaptation, or are partly crippled, so that they cannot come to the assistance of their allies when these are pressed by inclement elements. In such morbid conditions it is often prudent to seek climates where the weak or diseased organs are not so much taxed, and where these, if possible, can recover again greater strength, and become by degrees enabled to respond to the demands of more changeable climates.

Which are good climates for invalids? There are no *perfect* climates *for invalids;* some have defects in one direction, others in another. We can speak only of *fairly good* climates for given cases of disease or weakness in given constitutions, where the influences injurious to the given case are likely not to exist at all, or to a lesser degree than at other places, and where at the same time influences exist, which, when properly utilised, effect general improvement of the constitution, and thus facilitate the recovery of the diseased or weakened organs as far as is possible. "Pure air and water, the possibility of spending a great part of the day in the open air, and good hygienic and dietetic arrangements are primary conditions; the presence of a good local doctor is most important; a certain harmony between the invalid and the social and physical relations of the health-resort is a great help."

In every instance it is necessary to examine whether one has to deal with a torpid, or bilious, or erethic, or lymphatic constitution, or a combination of several of them, and, in accordance with the result of this examination, we have to select a more stimulating, a more sedative, a marine or inland climate, or one of low or high elevation.

As it is important in other ways of treatment, so it is important especially in climatic treatment, to weigh the amount of vigour of a constitution, its power of resistance and adaptation. In torpid constitutions, with fair residue of vigour, climates with low air temperatures, dry atmosphere, much sun-heat, and a certain amount of wind—viz., stimulating or bracing climates—are very beneficial, while in erethic constitutions, with little power of resistance, they are mostly injurious. In constitutions of the former kind, appetite, digestion, nutrition, the power to take exercise, and create heat become increased; in those of the latter kind they are lowered: hence the winter climate in the high Alps acts favourably on the former and unfavourably on the latter, which are more benefited by warm, equable, still, tolerably humid—*i.e.*, sedative—climates.

A great drawback in selecting climates for given cases, is that the climate of a place is not a fixed, immutable quality and quantity, but that it is a constantly changeable compound, and that it is impossible exactly to predict how the season at a certain place will be.

The selection of the right health-resort is, therefore, by no means always an easy matter; and if the best climate has been found, success is not yet insured, for the physical climate of a place alone is rarely by itself sufficient to effect a cure. Judicious arrangements must assist. A health-resort for serious invalids ought to have verandahs, which can be opened and shut, to enable the sick person to be in the air and in the sun without fatigue and risk. There ought to be sheltered walks with comfortable seats, some of which ought to be rotatory, with arrangement for shelter from rain, wind, and sometimes sun, to be turned round according to circumstances; or seats with different aspects and shelter from every wind, as at Hastings and St. Leonards, but unfortunately not at other health-resorts. Hammocks, too, are very useful in many cases.

But in addition to a good climatic resort and judicious arrangements, the invalid himself must be judicious. Sir James Clark said in the introduction to his work:* "But if he would reap the full measure of good, which his new position places within his reach, he must trust more to himself and to his own conduct than to the simple influence of any climate, however genial; he must adhere strictly to such a mode of living as his disorder requires; he must avail himself of all the advantages which the climate affords, and eschew those evils from which no climate or situation is exempt; moreover, he must exercise both resolution and patience in prosecuting all this to a successful issue." This includes the care in the selection of the house, the aspect and arrangement of the rooms, the clothing, the quantity and quality of food, and the times of meals; the amount and nature of exercise, and the hours for taking it; and as all this must be adapted to the exact condition of the invalid, the guidance of the local doctor is required, the more so as the condition of the patient is not immutable but constantly varying, and thus requiring change of management, and very often change of the health-resort; for there are many cases where it is of great importance to spend only a time at one place, and then to proceed to another. It is often difficult to decide this point, and it requires careful consideration, but if without any cause the improvement stops, or a retrograde step is made, it is time to inquire whether a change is not required.

Much of the want of success in climatic treatment depends on the absence of proper control. It is a different matter with persons suffering merely from residence in close cities and narrow rooms, or from hard study, or anxious and exciting occupation; these generally require only relaxation, and the selection of the climatic resort, or moving from place to place, may be left to their own choice; but the real invalid is very rarely able to guide himself, however great otherwise his intelligence may be, and even his knowledge of the human body.

Which are the ailments benefited by climatic treatment? In former years it was the prevailing opinion that the beneficial effects of climate were limited principally to diseases of the respiratory organs, and especially to consumption. This, however, is a great mistake. There is scarcely any chronic disease, the treatment of which cannot be assisted by climate. It would be out of place to attempt to give *general advice*, for as we said before, every single case requires careful and individualising consideration. We will restrict ourselves, therefore, to the briefest survey of some of the principal conditions.

Scrofula, in its manifold forms, requires improvement of nutrition and acceleration of tissue change. Residence at the sea-side, with abundant inhalation of pure sea-air, in many cases assisted by sea-water bathing, is most important. Children with tendency to scrofula ought to be educated at the sea-side. According to the power of resistance the selection ought to be guided—whether the locality is to be colder or warmer, exposed or sheltered. In delicate persons, or where there are complications, the more sunny winter at the Mediterranean is preferable; but, as a rule, the shores of the British Islands contain the best climates and the best hygienic and dietetic elements in the world for the management and prevention of scrofulous complaints.

* "Sanative Influence of Climate," 1846 (p. 10.)

Gout and chronic rheumatism are aggravated by damp cold; therefore it is often necessary to recommend the dry, warm, sunny climates, such as the Mediterranean shores, or Upper Egypt, or Helouân, near Cairo, or Hamman R'hira, in the province of Algiers; the two latter places combining hot baths with delightful climates. But permanent dietetic management and exercise are equally important as climate, and in most cases more so, and change of climate, as well as spa treatment, ought to be only transitory helps, to be dispensed with as soon as a certain improvement has been obtained.

Affections of the heart require such different management according to their nature, and especially their complications, that it is impossible to generalise. This much, however, may be said, that the higher mountain regions are mostly quite unsuitable, while moderate elevations, especially in wooded districts, are in summer generally preferable to the sea-shore; and that winter in fairly warm and dry regions, with level walks, is useful.

Affections of the kidneys and urinary organs are benefited by warm, dry, and sunny climates, with only moderate wind, such as Egypt; but with care the Western Riviera may be rendered beneficial, and even Rome and Naples occasionally allowed.

Dyspepsia, in its thousand forms, requires above all careful study of the constitution and the actual condition and working of the stomach and intestines, and corresponding advice as to diet and exercise. In erethic constitutions, with tendency to irritation and sub-inflammation of the gastric mucous membrane, the sedative climates are necessary; in torpid constitutions the stimulating mountain and sea climates, well-selected spa treatment, and travelling *per se* are useful.

In *mental depression* and *hypochondriasis*, travelling, with more or less prolonged stays at localities offering social recreation and occupation with art or antiquities, or any other object of interest to the valetudinarian, such as Florence, Rome, Naples, and Egypt. In summer, mountain climates, with moderate climbing or yachting, may be recommended, according to the individual condition.

Asthma, if caused by emphysema and heart disease, is best treated at equable sedative climates in erethic subjects; by dry, warm, and stimulating climates in relaxed constitutions; if caused by catarrhal conditions in young individuals, high elevations generally afford alleviation, and sometimes cure. There is, however, an element of uncertainty in all cases combined with asthma, and the effects of certain localities cannot be predicted before a trial. This is still more the case with so-called *nervous asthma;* in some cases high elevations, in others stimulating, in others sedative inland climates, are suitable. Great is the suffering often at some of the best climates of the Rivieras, as Dr. Frank has observed in several cases at Cannes, and the removal brings sometimes instantaneous relief.

In cases of *anæmia* and *chlorosis* localities are to be recommended where the weak persons can be in the open air during the greater part of the day without fatigue, and without exposure to heat and cold, such as the mountain, wood, and the cool sea climates of England in summer; and sunny and fairly warm sea climates in winter.

Malarious affections are best suited to high elevations, away from sources of malaria, and to the sea climates of England.

In *convalescence from acute diseases* change of climate is mostly very useful; but much care is required, as the whole constitution is often in a condition of great delicacy, so that fatigue, a chill, or unaccustomed food, may produce serious effects. A short distance from home generally suffices for the first, to allow the gathering of some degree of strength. Later on, the sea-shore, or the mountain, or the ship, may be decided on.

In *climacteric* conditions of life, as well in men as in women, travelling or repeated changes of locality, with occupation and exhilaration, materially assist the invalid in regaining the natural balance.

There are innumerable states of "delicacy of constitution and derangement of the system, more especially in childhood and youth," says Sir James Clark, "and which cannot be strictly classed under any formal disease," in which climate is a valuable remedial agent. No great distance is necessarily required in these cases, but the east and south-east coast of England, Tunbridge Wells, and other bracing inland places in summer, Bournemouth and Ventnor in winter, offer all that is required.

In *senile* or *old age* affections, climates with mild and sunny winters and springs are preferable to cold, damp, and dismal regions. There are many conditions of *premature senility* or *old age* of the one or the other organ of the body which are not so patent. If, in comparatively young persons, the hair falls out or becomes grey, this local old age is recognised; but it is rarely assumed that a similar process of old age may occur in the organs of circulation, of digestion, or nervous system, and the symptoms arising from the defective working power of such prematurely old organs are often complained of as disease. Such conditions cannot be *cured* either by medicine or climate, but the life must be so arranged that the demands on the aged organ are diminished, and that its energy and nutrition are, as far as possible, kept up by a limited amount of work. In this direction climate can be rendered very useful.

The *diseases of the respiratory organs*, including *consumption*, which furnish the greatest contingent of visitors to the climatic winter resorts, have been repeatedly mentioned in the discussion of different climates, so that we need not here repeat the localities generally suitable to them; the special class of climate suitable to every case can be found only by the appreciation of all the circumstances of the sick person. We will only remind the reader that not only is the constitution to be taken into consideration, but also the stage of the disease, that the same individual may, and often does, require in different years, and even in the same year, different localities, according to changes which take place in the local and general condition. There is no disease which requires so much circumspection, and patience, and perseverance, as consumption. In cases where the disease has made much progress, the treatment must be extended over many years. The general remark previously made—that the invalid should be under the strict control of a local physician—applies to no disease more than to phthisis; and here it is our duty to remark that few consumptive invalids, even medical men included, however intelligent otherwise, are able to judge for themselves. It is rare that they form a correct idea of all the features of their condition, and the agencies necessary for them towards a cure. It is difficult to do so in a disease extending over years; and in many instances the brain function is deteriorated with the rest of the body. It is a sad experience, which every one of us has to make very often, that the success of climatic treatment proceeds to a certain point, when the patient through an avoidable imprudence contracts a chill, an attack of bronchitis, or pneumonia or pleurisy, or of blood-spitting, and thus throws himself back for years, or renders his recovery impossible. Nowhere is this system of non-control worse than at the Rivieras, where the invalid is in company with many healthy persons, and where he sees the doctor only when he feels specially ill, and between his visits does what he likes or thinks suitable.

The Uses of Home Climates.

Under the term "Home climates" we will comprise the homes of invalids and their immediate neighbourhoods. It has been said before that the climates of England may be regarded as the most invigorating to healthy persons, though not without defects to invalids; and also that for the latter there are nowhere perfectly good climates. The invalid who is obliged to remain at or near home must above all things not consider himself doomed, but must learn how to avail himself of all the advantages at his command, and of the means to avoid or defend himself from the disadvantages of his home climate. There are some advantages of foreign climates which he cannot have to the same degree, but by using well what he has he may often obtain quite as much. He must learn:—1, how to be much in the open air; 2, how to have the air in his room as pure as possible; 3, what clothing to wear; 4, what and when to eat and drink; 5, how to take a proper amount of exercise and rest; and 6, how to manage the skin. The greatest part of the benefit obtained from foreign residence results from attention to these six points, which the invalid, when sent abroad, is tolerably ready to adopt at the authoritative dictation of the local doctor, but equally apt to neglect when he remains at home. When he goes abroad he knows that he does so entirely on account of his health, and that the recovery of his health is his main duty for the time being, while at home he has, or thinks that he has, other duties besides. If the invalid when abroad neglects to attend to the points just mentioned, he does not gain the full benefit of the climate, and often is not cured, nor even improved. The invalid at home ought to feel that, as he is under less favourable circumstances, he must all the more use his whole intellect to obtain his end. It is, indeed, in many instances, want of proper intelligence and appreciation of circumstances which renders an originally manageable complaint incurable; and, on the other side, it is often pleasing to see how a strong will and proper comprehension of all the circumstances of the situation, internal and external, leads in the course of time—sometimes long—to a more or less perfect cure of a dangerous chronic illness. One of the difficulties at home is, that the invalid is in the midst of comparatively healthy persons, who can, without harm to themselves, more or less, do as they please, and that an inborn or acquired feeling of good-fellowship—misplaced in such a situation—leads him involuntarily to do as they do. At a really *good* health-resort *every one ought* to be under the *strictest rules*, and without much difficulty the invalid learns to appreciate the usefulness and necessity of the strictness of rules, and the habits of the place, and falls in with them heart and soul, however irksome they might be at home. It is true that such health-resorts are rare, and that the benefits obtained by invalids under the best climatic conditions, without proper guidance, are generally inferior to those at more defective resorts, with strict and judicious superintendence. We have mentioned before the Sanitaria at *Goerbersdorf* in Silesia, and at *Falkenstein*, near Soden, for the cure of pulmonary diseases. The climatic conditions are by no means all that can be wished, but the results obtained by judicious and energetic guidance of the patients, who all live within the establishments, or, at all events, close to them, and under their rules, are very satisfactory, and the main part of the rules refers to the six points just mentioned, attention to which is indispensable. We have not the space to enter into them in detail, and we can with perfect confidence leave the subjects of food, of stimulants, of exercise, of dress, of travelling, of surroundings, and of the management of skin, to the able authors of the respective papers in this book. In chronic diseases, especially in consumption, there is a certain degree of feebleness, owing to which external influences, not injurious to others, cause excessive effects, and the feeble organs are unable to adjust the derangements thus produced. The aim of our general management must be to strengthen the relative health of the individual, so as to enable the invalid better to resist injurious influences and to compensate the effects. The systematic taking of food, the culture of the skin, exposure to pure air, regular exercise, are the means to obtain this result. It is at first difficult in an inclement climate to be much in the air, but gradually the habit can be acquired by the majority of invalids, and rain or snow in many cases ought not to be obstacles to exercise, the air itself being often best when it rains or snows, or soon after. It is frequently necessary to feel one's way, but on the whole a strong and bold hand in guiding the invalid is an advantage. More than one baker, who had become consumptive by work in the bakehouse and in the shop, has been cured by pushing the bread cart every day for three or four hours through the streets in all weathers; and the same has occurred with clockmakers from the Black Forest, who, having become consumptive in the close work-room, left it, and carried round their clocks from house to house.

If it is possible for the invalid to select a situation, let it be on a dry soil or rock, on a slope (not at the bottom of a valley, in a southern or south-western aspect) with woods—pine woods for choice—at no great distance, away from large towns and from all air-contaminating influences.

Another point in the question of home climates is, that we must not always be satisfied with the surrounding conditions as they are, but must endeavour to improve them; for instance, by building walls reflecting the sun, and walls sheltering from wind; and "by building glass corridors, and suitably warming them." Unfortunately, we look, as yet, in vain for such arrangements at our favourite home health-resorts of the south and south-west coasts. Professor Frankland's lecture at the Royal Institution, and his already often-quoted paper, "Climate in Town and Country," are full of valuable facts and advice. He even suggests the removal of the fearful smoke and fog nuisances, which cause the premature deaths of so many invalids. We have no doubt that he is right, and wish that a Royal Commission were charged to inquire into the means for carrying out this much-needed reform, which would bring immeasurable benefit.

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